Bind with v. 1.

Do not remove this Co-y

TRANSACTIONS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY

OF

NEW-YORK.

11717

VOLUME II.—PART I.

NEW-YORK:

PUBLISHED FOR THE SOCIETY BY BLISS AND WHITE,
No. 128 Broadway.

Printed by D. Fanshaw, No. 1 Murray-street.

1825.

No more published

TRANSACTIONS

OF THE

LITERARY AND PHILOSOPHICAL SOCIETY

OF

NEW-YORK.

11717

VOLUME II.—PART I.

OFFICERS OF THE SOCIETY,

ANNO 1825.

DEWITT CLINTON, LL. D., PRESIDENT.

DAVID HOSACK, M. D., F. R. S.
SAMUEL L. MITCHILL, M. D., LL. D.
JAMES RENWICK, ESQ. Prof.
} VICE-PRESIDENTS.

JOHN W. FRANCIS, M. D.
JOHN B. BECK, M. D.
} CORRESPONDING SECRETARIES.

JER. VAN RENSSELAER, M. D.
WILLIAM B. LAWRENCE, ESQ.
} RECORDING SECRETARIES.

JAMES E. DE KAY, M. D.
ROBERT GREENHOW, M. D.
} CURATORS.

HENRY BREVOORT, JUN. ESQ. TREASURER.

COUNCIL.

GEN. MORTON,
PROF. J. GRISCOM,
PROF. M'VICKAR,
DR. V. MOTT,
DR. MAC NEVEN,
REV. DR. WAINWRIGHT,
HON. W. P. VAN NESS,
WM. GRACIE, ESQ.
DR. S. W. MOORE,
HENRY WHEATON, ESQ.
DR. J. WATTS,
REV. MR. SCHRŒDER.

COMMITTEE OF PUBLICATION.

PROFESSOR RENWICK,
H. BREVOORT, JUN., ESQ.
PROFESSOR J. W. FRANCIS,
GENERAL MORTON,
DR. J. VAN RENSSELAER.

*** "The Society wish it to be distinctly understood that they disclaim all responsibility as to the verity of facts or the soundness of the speculations contained in the Communications they may publish. These must rest with their respective authors."

At a Special Meeting held at the New-York Institution in June, 1825,

Resolved, that the Committee of Publication forthwith issue Part I. of Volume II. of the Transactions of the Society.

J. VAN RENSSELAER,
Recording Secretary.

TRANSACTIONS.

Art. I.

ON CERTAIN PHENOMENA OF THE GREAT LAKES OF AMERICA.

BY DE WITT CLINTON, L L. D. President of the Society.

[Read before the Society, November 13th, 1817.]

It has been until within a few years generally understood that there are no tides in the Great Lakes of America; and that the Mediterranean, Black, Caspian, and Baltic Seas, and other great waters of the old world, are also exempt from their influence. More accurate observation has however indicated that this opinion is in some respects erroneous, and it is now considered doubtful whether it is not altogether so. It is confidently said that there are tides in the Mediterranean. At Toulon, three hours and fifteen minutes after the moon has passed its meridian, the tide rises one foot; and in the highest spring tides, augmented by the concurrence of other causes, it swells as high as two feet.* The Lake of Geneva and the Lake of Constance are subject to an occasional rising and falling of their waters three or four feet, several times in succession, by a sort of oscillating motion, which phenomenon is denominated Seiches.† There are certain appearances connected with our Lakes that resemble the operation of tides, and there are others of a character entirely dissimilar. As the Western Lakes contain the greatest collections of fresh water in the world, all the phenomena connected with them are deeply interesting in relation to Geography, Agriculture, Trade, and Natural Science: I shall therefore devote this memoir to this subject.

* Forster's History of the voyages in the North.

† De Saussure's Voyages dans les Alpes. Kinlock's letters from Geneva and France. Coxe's Switzerland. Simond's Switzerland.

1. In our Lakes there is, apparent to every observer, a sort of flux and reflux, which we would naturally attribute to the wind, and might therefore pass it over without particular attention. But a more discriminating view has resulted in a conviction with many accurate and distinguishing observers, that the peculiar motion of the waters is entirely independent of the winds; that it occurs within stated periods; that it is not subject to the irregularities of occasional or accidental causes, but that it depends for its existence upon a power operating with unceasing vigor, and with unintermitted regularity at the same place, although varying as to the quantum of its influence at other places. On the other hand, it is supposed by some that these appearances are occasional and irregular, and do not result from uniform causes. I shall now refer to some prominent authorities on this subject.

La Hontan is the first writer who touches on this phenomenon.* "On the 29th of May, 1689, we came," said he, "to a little deep sort of a river, which disembogues at a place where the water of the Lake (Michigan) swells three feet high in twelve hours, and decreases as much in the same compass of time. Our tarrying there three or four days, gave me an opportunity of making the remark." An appearance of this nature could not escape the observing eye of Charlevoix, the most sagacious, able, and learned of the French writers on America. Speaking of Lake Ontario,† "I observed," said he, "that in this Lake, and I am told that the same thing happens in all the rest, there is a sort of flux and reflux almost instantaneous, the rocks near the banks being covered with water and uncovered again several times in the space of a quarter of an hour, even if the surface of the Lake was very calm, with scarce a breath of wind. After reflecting for some time on this appearance, I imagined it was owing to the springs at the bottom of the Lakes, and to the shock of their currents, with those of the rivers which fall into them from all sides, and thus produce those intermitting motions."

Pownall‡ says, "Lake Ontario, like the Mediterranean, the Caspian, and

---

* La Hontan's North America. Vol. 2d.

† Journal Historique, d'un voyage, de L'amerique, Letter 13.

‡ Topographical description of part of North America.

other large invasated waters, has a small rising and falling of the water, like tides, some twelve or eighteen inches perpendicular."

These are the only authorities of an old date to which I have had access. Those which I now refer to are of recent observation, and some are derived from oral communication. Mr. Benjamin Wright, a very judicious and intelligent gentleman, and one of the principal engineers on the Western Canal, informs me, that at a place called Mexico, about twenty miles from Oswego, Lake Ontario ebbs and flows every hour and a half about six inches, and that the flood is highest when the wind is from the shore.

A gentleman of veracity and intelligence, who resides at the mouth of Genesee River, says that this Lake rises and falls four times each in every hour, whether there be a wind or not: that the smallest rise is four, and the highest twenty-eight inches, and that this occurs during a perfect calm.

A similar appearance occurs on Lake Champlain. Captain Winans, one of the proprietors of the Steam Boats, who resides at Burlington, in Vermont, assures me that in summer, when there has been a perfect calm for several days, he has observed at that place a flux and reflux of the Lake four times every hour, with great regularity, and at every access rising four inches, as was obvious from a mark made on a log.

Captain Storrow, a gentleman of talents, says, in a printed letter to General Brown, "while at Green Bay, I made observations on the ebb and flow of a Lake tide. At eleven o'clock A. M. I placed a stick perpendicularly in the water—at half past nine P. M. the water had risen five inches—at eight next morning it had fallen seven inches—at eight same evening it had risen eight inches. During this period the wind was in the same direction, blowing generally against the flow of the tide."

Judge Woodward, of Michigan, in a letter to Doctor Mitchill, states, that Mr. Benjamin F. Stickney, who resides on the Miami River of Lake Erie, some miles below the rapids, and a few miles from the mouth of the River, made observations on this subject for more than a fortnight, in June, 1820; the result of which is a conviction in his mind that there is a regular tide in Lake Erie—that it flows and ebbs twice in twenty-five hours, at intervals of about six hours and eleven minutes, and that it is greatest at the new and

full moons, and least at the quarters. The minimum of rise within the period during which the observations were made, was as much as eight inches. The maximum of rise within the same period, was as much as forty inches. Mr. Lecuyer, a gentleman equally intelligent, expressed the same opinion as to a tide at Green Bay.

If these exhibitions of a flux and reflux of the Lakes were only occasional and incidental, not uniform, and periodical, there would be perhaps no great difficulty in assigning satisfactory causes. The *Seiches* of the Lake of Geneva have been ascribed by Mr. Bertrand to the influence of electrical clouds which attract and raise the waters of the Lake, and he supposes that this water afterwards falling, produces those undulations of which the effect, like that of the tides, is most sensibly felt where the shores are most approximated.

A more probable cause may be the unequal pressure of the atmosphere on the waters, which will of course rise higher as the weight of the incumbent air is less, and fall as it becomes greater; and these changes being almost always in operation, may account for the almost continual ebb and flow of the lakes.

The cause assigned by Charlevoix is entirely unsatisfactory; and it is premature to form a theory on the subject. Facts and experiments ought to precede speculations; and we must leave it to future inquirers to ascertain the facts in extenso—to investigate the causes, and to determine whether this phenomenon be owing to the pressure of the atmosphere—the influence of the moon—the attraction of the clouds—the convexity or motion of the globe, or any other assignable agency.

2. There is an annual rise and fall of Lake Erie. The rise generally commences in March, and terminates about the middle of July; and this is the case sooner or later with the other Lakes. It is owing to the great accession of water produced by the melting of snow and ice, and by the vernal rains; and the fall is occasioned by the failure of most of these sources of supply in summer.

3. There is, besides the annual rise of the Lakes, a more extended periodical one, at least every three years, and then a correspondent declension.

Some extend the time to five, and others to seven years. Some say that the highest rise is seven feet, and others differ as to the exact altitude; but there can be no doubt of the general certainty of the fact. Lake Erie began to rise in 1811, and continued to increase until 1815, when it was two feet higher than was ever known. The overflowing of the waters destroyed trees on the low lands more than two hundred years old, and the inhabitants of Detroit, which is an ancient settlement, had never seen or heard of such a rise before. It fell a little in 1816, rose again in 1817, and decreased until 1822. It was in June last on the rise, and one and a half feet higher than usual. In 1810 I walked on Bird Island; an Island situate at the outlet of Lake Erie. In 1816 it was almost covered with water, and was scarcely visible. I am informed by an intelligent ship-master on the Lakes, "that when he visited Detroit in 1797, the waters were at their height. He went to the south the following year, and did not return to that place until 1802, when he found the waters considerably lower. Having understood that there was a rise and fall every seven years, he determined to ascertain how great it was; for which purpose he caused marks to be made on a solid wharf that had been built more than twenty years before, and was perfectly firm and immoveable; and he found that the water declined on an average about an inch a year for nine years. What the fall was for five years during his absence he did not know, but it may be fairly stated at three times as much yearly; that is, fifteen inches, if compared with subsequent occurrences of a similar character. The Lake began to rise again in 1811, in the spring of which it rose six inches, but during the summer it fell two inches. In 1812 it rose fourteen inches, and subsided three inches, leaving a nett gain of fifteen inches in two years. The surrender of Detroit to the British, in October, 1812, compelled him to leave the country; but in October, 1813, he returned with the fleet, and the water was then at its greatest altitude, having in that year gained 12 inches—in all twenty seven inches. In 1814 and 1815 it was stationary. In 1816 and 1817 it fell at least eighteen inches. And he further supposes, from appearances at Michillimackinack, that the whole town of that Island was formerly under water, and that one of the ancient outlets of the Lakes was by Chicago, which

he states at only thirteen feet above the present level of the Lake; and he says that every spring you may pass up the Chicago River and carry in the shoalest place five feet water into the Illinois, and from thence into the Mississippi."

Mackenzie, in his account of his voyages through the Continent, to the Frozen and Pacific Oceans, in 1789 and 1793, says, that "along the surrounding branches of Lake Superior, there are evident marks of the decrease of its waters by the lines observable along them. The space, however, between the highest and the lowest is not so great as in the smaller Lakes; as it does not amount to more than six feet; the former, or highest lines are very faint."

4. The Lakes are subject to extraordinary swells and risings. On the 18th of October, 1764, Colonel Bradstreet, who had been on an expedition against the Western Indians, broke up his camp at Sandusky to proceed on his return to Albany by Lake Erie. In the evening, as he was going to land the troops, a sudden swell of the Lake, without any visible cause, destroyed several of his boats, but no lives were lost. This extraordinary event was, however, looked upon as the precursor of a storm, and accordingly one soon occurred which lasted several days. Mackenzie, before quoted, states that a very curious phenomenon was observed some years ago at the Grand Portage in Lake Superior, for which no obvious cause could be assigned. The water withdrew with great precipitation, leaving the ground dry that had never before been visible; the fall being equal to four perpendicular feet, and rushing back with great velocity above the common mark. It continued thus falling and rising for several hours, gradually decreasing until it stopped at its usual height."

The following occurrence, equally extraordinary, took place on the British side of Lake Erie on or about the 30th May, 1823, which is thus described. "A little after sunset Lake Erie was observed to take a sudden and extraordinary rise, the weather being fine and clear, and the lake calm and smooth. It was principally noticed at the mouths of Otter and Kettle Creeks, which are twenty miles apart. At Otter Creek, it came in, without the least previous intimation, in a swell of *nine feet perpendicular height*, as

was afterwards ascertained, rushed violently up the channel, drove a schooner of 35 tons burthen from her moorings, threw her upon high ground, and rolled over the ordinary beach into the woods, completely inundating all the adjacent flats. This was followed by two others of equal height, which caused the Creek to retrograde a mile and a half, and to overflow its banks, where water was never before seen, by seven or eight feet. The noise occasioned by its rushing with such rapidity along the winding channel, was truly astonishing. It was witnessed by a number of persons.

"At Kettle Creek several men were drawing a fish net in the Lake, when suddenly they saw the water coming upon them in the manner above mentioned; and, letting go their net, they ran for their lives. The swell overtook them before they could reach the high bank, and swept them forward with great force; but, being expert swimmers, they escaped unhurt. The man who was in the skiff pulling in the sea line, was drove with it a considerable distance over the flat, and grounded upon a small eminence until the water subsided. There were three successive swells, as at Otter Creek, and the effects up the creek were the same, with this difference, the water only rose seven feet. In both cases, the lake, after the three swells had spent their force, gradually subsided, and in about twenty minutes was at its usual height and tranquillity. It was observed at other places along the shore, but the high steep banks did not admit of the same observation. In all, however, there was a general correspondence as to the height of the rise.

"Conjecture will doubtless be awake as to the cause of this most remarkable phenomenon; but it must only be conjectured, for it was unattended with any circumstance that could remotely hint at a probable cause. But such was the fact, and it must furnish its own comment."

Some have supposed that the occasional rise of Lake Erie is owing to the strong south winds in Lake Michigan; but this hypothesis cannot account satisfactorily for this appearance. Volney supposes that Lake Ontario is the crater of a volcano. Mackenzie says, that many of the Islands of Lake Superior, display a conformation of lava, intermixed with round stones of the size of a pigeon's egg. The western country abounds with what are called burning springs, consisting of volumes of hydrogen gas,

issuing from spiracula in the earth, and it is underlaid with sulphur, coal, bitumen, and other inflammable substances. In boring for salt at Rocky Hill, in Ohio, about a mile and a half from Lake Erie, after proceeding to the depth of one hundred ninety-seven feet, the auger fell and salt water spouted out for several hours. After the exhaustion of this water, great volumes of inflammable air issued through the aperture for a long time, and formed a cloud; and by ignition by the fire in the shops of the workmen, consumed and destroyed every thing in the vicinity.

Whether the country round the Great Lakes is volcanic or not, is not material to the present inquiry. We know that the bowels of the earth are stored with inflammable materials, and that there exist strong indications of subterranean communications at enormous distances. Indeed every thing in earthquakes seems to indicate the action of elastic fluids seeking an outlet to spread themselves in the atmosphere. At the period of the last, and the preceding destruction of Lisbon, according to Humboldt,* the sea was violently agitated as far as America. For instance, at the Island of Barbadoes, more than twelve hundred leagues from Portugal, and on Lake Ontario, strong agitations of the water were observed in October, 1755. The first destruction of Lisbon took place on the first day of November, 1755, and the last on the thirty-first day of March, 1764, the very year in which the sudden swelling of Lake Erie overwhelmed some of Colonel Bradstreet's vessels.

Bakewell, in his Geology, states that "during the earthquake at Lisbon, in 1775, almost all the springs and Lakes in Great Britain, and in every part of Europe, were violently agitated, many of them throwing up mud and sand, and emitting a fetid odour. The morning of the earthquake, the hot springs at Toplitz, in Bohemia, suddenly ceased to flow for a minute, and then burst forth with prodigious violence, throwing up turbid water, the temperature of which was higher than before. The hot-wells at Bristol were coloured red, and rendered unfit for use for some months afterwards. Even the distant waters of Lake Ontario, in North America, were violently agitated at the time."

* Humboldt's personal narrative.

"The connexion which earthquakes (continues Bakewell) have with distant volcanoes, and their frequency at particular periods, are truly remarkable. The tremendous earthquakes in 1812, in the Carraccas, were followed by an eruption in the Island of St. Vincents, from a volcano that had not been burning since 1718, and violent oscillations of the ground were felt, both in the Islands and on the coast of America."

The late swell of Lake Erie has been followed by shocks of earthquakes, as well at a distance, as in the vicinity. Have we not therefore reason to believe, that the extraordinary agitations which sometimes occur in the Lakes, are connected with earthquakes, and produced by the same causes?

ARTICLE II.

An ACCOUNT *of* EXPERIMENTS *to ascertain the length of the* SECONDS PENDULUM, *at* COLUMBIA COLLEGE, *New-York; by* CAPTAIN EDWARD SABINE, *of the Royal (British) Artillery; F. R. S. and Honorary member of the Historical and of the Literary and Philosophical Societies of New-York.*

(Read April, 1823.)

PREVIOUSLY to entering into the detail of the experiments which form the subject of this paper, it may be desirable to premise a brief notice of the occasion and motives which led to their being made, in particular, in the city of New-York.

I had been engaged, in the summer of 1822, in conducting a series of experiments of the same kind, at several stations near the equator, to be combined ultimately with others in the middle and northern latitudes, in deducing a more precise knowledge of the figure of the earth than has been heretofore obtained.

In the prosecution of this design, I was desirous of an opportunity of adding a station in or about the 40th degree of latitude, in the course of my return from the West Indies to Europe; and should probably have selected New-York for such purpose, from its convenience of access and anchorage, and from the confidence with which every facility and assistance which might be required could be anticipated; even if a stronger inducement had not presented itself, in the hope that experiments of this nature, made in one of the principal cities of the United States, might have a value beyond their immediate object.

A desire of permanently fixing the national standard of linear measure, by comparison with some determinate and ascertained length in nature, has been strongly excited, for some years past, in several countries of Europe; in Great Britain and in France in particular, it has given rise to extensive and laborious operations, carried on since the last century, for the measurement of the arc of the meridian, passing through those countries; and more

recently, to the determination of the length of the seconds pendulum in London and in Paris, by processes of great ingenuity and refinement. The interest with which these researches have been regarded has not been confined to Europe; it has prevailed especially in the United States, where the object has been justly considered—not merely of scientific value, but of national importance; and as such has excited the solicitude, and already a considerable portion of the attention of the Federal government.

Viewed in its connexion with national measures, the accurate determination of the length of the Pendulum becomes of the first importance; since it affords the only method *yet known* of identifying a standard, of recovering it if lost, and of transmitting it with certainty to the most distant posterity. Whatsoever may be the unit of linear measure in different states, whether assumed as a supposed aliquot part of the terrestrial meridian, as in France, or derived from accident rather than design, as in Great Britain, or originating in a purely arbitrary assumption, it must be alike dependent on the Pendulum for its verification.

It may be expected, therefore, that as governments shall be successively excited to place the measures of their respective dominions on a fixed and invariable basis, the length of the pendulum, vibrating some definite portion of time at a convenient place in each territory, will be determined by experiment, as a natural standard of reference and comparison for the national scale.

The only states of Europe in which such experiments have hitherto been made, are those which have been already named; the methods by which the determination has been effected in the two countries, differ from and are independent of each other; it is not necessary, on this occasion, to notice their respective merits, further than to observe that a high degree of skill and delicacy is required in conducting them, and that their execution has afforded an adequate and very admirable display of these qualifications.

There is a third mode, however, the accuracy of which is far less dependent on the skill of the conductor, by which, when the length of the pendulum, vibrating as above, has been ascertained at any one place, by either of the preceding methods, its relative length at any other station may be made

known, with as rigorous an exactness as if the measurements had been made at both places by the original procedure: this mode is founded on a well known property in pendulums, that their lengths are inversely as the squares of the numbers of their respective vibrations in equal times: the process consists in determining, accordingly, the number of vibrations of an invariable pendulum of comparison at the two stations; i. e. where the length is already known, and where it is purposed to be known.

It is this latter method which I have employed to ascertain the difference in the length of the seconds pendulum in London, and in New York; and, by consequence, the absolute length at the latter station, on the presumption that it has been correctly determined at the former.

The possible value, then, of the experiments which form the subject of this paper, beyond their immediate object of assisting in the determination of the figure of the earth, may be thus stated: should it be desired to establish a standard in nature within the territory of the United States, wherewith to compare and perpetuate the national scale of linear measure; and should New-York be deemed in other respects an unexceptionable locality at which to institute a series of experiments for this purpose, or either of the original methods of London or of Paris, an oppprtunity is hereby presented of comparing the result of such an operation with that which has been obtained in London, and which is now conveyed to New-York by pendulums of intermediate comparison.

I proceed to the detail of the observations, which it is purposed to give at sufficient length to enable each individual to judge for himself of the degree of accuracy to which the conclusions may be considered to be entitled.

The experiments were made in Columbia College, by permission of the President and Trustees of that Institution, most kindly tendered as soon as my intention was made known to them by Dr. Hosack, and as thankfully accepted, since it is important that determinations of this nature should be made in public edifices, rather than in the houses of private individuals, as affording a greater probability of convenient access on future occasions of similar or connected operations. A vacant apartment, opposite the door leading into the gallery of the Chapel, was assigned for the pendulums, and the use of the Cupola permitted as a temporary observatory.

A common, though very good astronomical clock, was firmly attached to the wall of the apartment, nearly opposite the door; a strong iron frame designed to support a detached pendulum, the rate of which on that of the clock it was proposed to ascertain, was fixed at a proper distance above the clock, by screws of five inches in length, working in pickets of wood driven into the wall; the iron frame, the pendulum, and its agate support, corresponded in all respects to those used on a similar occasion in Great Britain, and described by Captain Kater, in the Philosophical transactions for 1819, pages 341, 342; and I may here remark, that the method of determining the number of vibrations in 24 hours of the invariable pendulum, by the interval elapsing between its coincidences with that of the clock, is the same as is described in an earlier paper of the same writer, in the volume for 1818, page 43, with this exception, that I am in the habit of noting the time of re-appearance of the disk on the pendulum of the clock, *after* its coincidence with the detached pendulum, as well as the time of its disappearance *previous* to the coincidence; and that the second which is completed *after* they have been seen to pass the opening in the diaphragm of the Telescope in apparent coincidence, and the one which is completed *before* the first appearance of their separation, are registered as the respective times, and their mean is considered as the true time of coincidence.

By favour of the gentlemen who superintend the administration of the customs in New-York, the instruments had been permitted to be landed not merely without duty, but without undergoing the customary formality of inspection, in consideration of the public utility of their purpose: they were disembarked on the 11th of December, being the day after my arrival, and were ready to have commenced the observations on the morning of the 15th; the weather, however, proved an obstruction until the 22d; a delay which may have been ultimately beneficial, in giving time to the astronomical clock to take up a more steady rate than it might possibly have had in the earlier days.

The pendulum being invariable in all respects, excepting in the effects of heat, an exact knowledge of its temperature at the times when its vibrations are under notice is essential to accuracy. In the attainment of this know-

ledge consists the greatest practical difficulty with which this method of experiment has to contend, and the source from whence error is most to be apprehended; the mass of brass of which the pendulum consists, does not or may not conform to changes of temperature so rapidly as the thermometer suspended as an index by its side; and when it is considered that, agreeably to the expansion of brass, a quarter of a degree of Fahrenheit's scale is equivalent to about one tenth of a vibration in 24 hours, or to $\frac{1}{10000}$th of an inch in the length of the pendulum, which is a very appreciable quantity, the necessity of extreme precaution will be evident; and especially if reducing the variation in the general temperature of the apartment in the 24 hours within as small limits as possible, by suspending screens of baize and matting before the windows, and by thus keeping the room constantly dark, except when entered for the purpose of observation, or of comparing the clock, (which were allowed to occupy no more time than they absolutely required.) The variation from the mean temperature in the 24 hours rarely equalled a degree and a half, although the range of the mean temperature itself exceeded that amount in the eleven days through which the observations of coincidences were carried.

The rate of the clock, or, in other words, the number of its vibrations in each 24 hours, from the commencement to the close of the series of coincidences, is the foundation of the corresponding rate of the detached pendulum: not finding readily a suitable situation for a transit instrument, I depended principally for this determination upon zenith distances of the sun and stars out of the meridian, observed with a repeating circle of six inches diameter, in the sufficient accuracy of which I had confidence from experience: the cupola afforded a convenient place for the use of the circle, having windows opening in four directions, the sills of which were enlarged for its support; the adjustments were carefully ascertained, although, as will be seen, the results are arranged in such manner as to render them finally independent of the principal sources of inaccuracy, arising from a want of adjustment: the times of observation were noted by a chronometer of Messrs. Parkinson and Frodsham, No. 423, in the steady and uniform going of which I had also had much experience, and which was compared periodi-

cally with the clock. Being desirous, however, of the fullest corroboration of accuracy, in the comparison of the clock with astronomical time, and the steeple of the Presbyterian Church in Murray-street being conveniently situated for the purpose, an eighteen inch astronomical telescope was firmly attached by a brass plate and screws to the side wall of the eastern window of the College Chaple, having a part of the steeple in its field of view, behind which the times of disappearance of three stars in the great bear were observed on the 24th of December, and on the 2d of January. The observations by both these methods, with a recapitulation of the several results, and the deduction of the daily rate of the chronometer from the 22d of December to the third of January, are subjoined, and are followed by a table, showing the periodical comparisons of the clock with the chronometer, and the rate of the clock on mean solar time finally deduced.

Observations to determine the rate of the Chronometer No. 423, *on mean Solar time, between the* 22*d of December,* 1822, *and the* 3*d of January,* 1823, *by Zenith Distances of the Sun and Stars out of the Meridian with a Repeating Circle, observed in the Cupola of Columbia College, New-York. Lat.* 40° 42′ 43″ *N. Long.* 74° 03.′ 5″ *West.*

December 22*d, P. M. Sun's U. L. Bar.* 30, 34. *Th.* 37.

Chronometer.	Level.	Readings, &c.	
		For the Zero.	Final.
8. 10 . 17, 2	+2−5	97 . 18 . 10	206 . 18 . 20
11 . 58.	−2−8	10	10
14 . 07, 6	+2−5	30	30
15 . 42, 4	+9+3	10	20
17 . 43, 2	+5−2	97 . 18 . 15	206 . 18 . 20
19 . 08.	+7−0	262 . 41 . 45.	262 . 41 . 45
Chr. 8. 14. 49, 4	+23−17		Level+ 3
M. T. 3. 13. 47. 33.	+3.		469 . 00 . 08
5 . 01 . 02, 07 423 fast m. time.			78 . 10 . 01 obs. Z. D.
			+4 . 32, 5 Ref.−Par.
			+16 . 17, 5 Semid.
			78 . 30 . 51. True Z. D.

December 22, *α Lyræ W. of the Mer. Bar.* 30,3. *Th.* 35.

Chronometer.	Level.	Readings, &c.	
		For the Zero.	Final.
11. 31 . 56,	+6−3	206 . 18 . 20	251 . 12 . 30
34 . 06, 4	+2−7	10	12 . 00
36 . 14.	−1−9	30	12 . 30
38 . 26, 8	+9−0	20	11 . 50
41 . 48.	+2−7	206 . 18 . 20	251 . 12 . 12, 5
44 . 08.	+7−2	153 . 41 . 40	153 . 41 . 40
Chr. 11. 37 . 46, 53	+26−29		Level−1, 5
M. T. 6. 36 . 43, 9	−1,5		404 . 53 . 51
5 . 01 . 02, 63.	423. fast m. time.		67 . 28 . 58 obs. Z. D.
			+2 . 26 Refr.
			67 . 31 . 24 True Z. D.

December 23d, *P. M. Sun's U. L. Bar.* 30, 26. *Th.* 20, 5.

Chronometer.	Level.	Readings, &c.	
		For the Zero.	Final.
8. 01 . 10.	+3−7	251 . 12 . 30	352 . 56 . 30
03 . 47, 2	0 0	12 . 00	20
05 . 18, 8	0−10	12 . 30	40
06 . 54.	0 0	11 . 50	30
08 . 39, 2	0 0	251 . 12 . 12, 5	352 . 56 . 30
10 . 35, 2	−6+4	108 . 47 . 47, 5	108 . 47 . 47,5
Chr. 8. 06 . 04, 07	−23+7		Level−8
M. T. 3. 05 . 04, 07	−8.		461 . 44 . 10
5 . 00 . 00.	423. fast m. time.		76 . 57 . 22 obs. Z. D.
			+4 . 15 Refr. −Par.
			+16 . 17, 5 Semid.
			77 . 17 . 54, 5 True Z. D.

December 23d, *Rigel East of the Mer. Bar.* 30, 26. *Th.* 17.

Chronometer.	Level.	Readings, &c.	Chronometer.	Level.	Readings, &c.
12. 21 . 39, 2	+1−9	53 . 20 . 30	12. 41 . 22, 8	+ 6−4	89. 43 . 10
24 . 53, 6	+8−4	. 10	43 . 18.	+11−0	2 . 50
27 . 21, 2	0 0	. 30	45 . 28.	+10−1	3 . 20
30 . 15, 2	+9−2	. 00	47 . 13, 6	+12+2	2 . 40
32 . 24, 8	0 0	53 . 20 . 17, 5	49 . 58.	+ 3−7	89. 43 . 00
35 . 02.	+1−10	360.	52 . 28, 4	+ 7−4	306. 39 . 42,5
12. 28 . 36.	+19−25	Level −3.	12. 46 . 38, 13	+51−16	Level +17, 5
7. 27 . 33, 9	−3.	413 . 20 . 14	7. 45 . 37, 17	+17. 5	396. 23 . 00
5. 01 . 02, 1		68 . 53 . 22	5. 01 . 00, 96		66. 03 . 50
	Refr.	+2 . 41		Refr.	+2 . 20
	True Z. D.	68 . 56 . 03		True Z. D.	66. 06 . 10

Chronometer fast mean time { 5. 01 . 02, 1. / 5. 01 . 00, 96. } 5. 01 . 01, 53.

December 24th, A. M. Sun's L. L. Bar. 30, 40. *Th.* 18.

Chronometer.	Level.	Readings, &c.		Chronometer.	Level.	Readings, &c.
25. 36 . 58	0 0	Zero.		25. 47 . 48, 4	+ 8—4	
38 . 40	0 0	105. 5 . 10	221. 4 . 40	49 . 18	+ 8—4	328. 26 . 15
40 . 30, 4	0 0	5 . 00	30	51 . 00, 4	+ 3—8	15
41 . 45, 6	+12+1	5 . 40	50	52 . 21, 6	+10 0	35
43 . 50, 4	— 6+4	5 . 10	40	55 . 04, 8	+ 9—2	10
45 . 00, 8	+ 3—8	105. 5 . 15	221. 4 . 40	56 . 29, 2	+ 7—4	328. 26 . 19
25. 41 . 07, 53	+20—14	254. 54 . 45	254. 54 . 45	25. 52 . 00, 4	+45—22	138. 55 . 20
20. 40 . 09, 33	+ 3.		Level +3.	20. 51 . 02, 6	+11 , 5	Level +11, 5
5. 00 . 58, 2			475. 59 . 28	5. 00 . 57, 8		467. 21 . 50
		Obs. Z. D.	79. 19 . 54, 7			77. 58 . 38
		Refr. — Par.	+5 . 15			+4 . 19
		Semid.	—16 . 18			—16 . 18
		True Z. D.	79. 08 . 52			77. 41 . 59

Chronometer fast of m. time { 5. 00 . 58, 2 / 5. 00 . 57, 8 } 5. 00 . 58.

December 29th, A. M. Sun's L. L. Bar. 30, 30. *Th.* 26.

Chronometer.	Level.	Readings, &c.		Chronometer.	Level.	Readings, &c.
25. 47 . 44	+ 8—2	222. 49 . 10	330. 45 . 00	25. 59 . 52, 8	— 3—12	70. 53 . 35
50 . 13, 2	+ 5—6	48 . 50	5 . 00	26. 00 . 56	0 0	3 . 10
51 . 54	0 0	49 . 40	5 . 20	01 . 50, 8	0 0	3 . 55
53 . 12	0 0	49 . 10	4 . 40	02 . 55, 2	+10+1	3 . 0
54 . 44	+ 9—1	222. 49 . 12,5	330. 45 . 00	04 . 02	+ 1—8	70. 53 . 25
56 . 26, 4	0 0	137. 10 . 47,5	137. 10 . 47, 5	05 . 22, 4	+ 3—6	29. 15 . 00
25. 52 . 22, 27	+22—9		Level +6, 5	26. 02 . 29, 87	+15—29	360.
20. 51 . 38, 03	+ 6 5.		467. 55 . 54	21. 01 . 44, 4	— 7.	Level —7
5. 00 . 44, 24			77. 59 . 19	5. 00 . 45, 47		460. 08 . 18
			+ 4 . 35			76. 41 . 23
			—16 . 18			+ 4 . 07
			77. 47 . 36			—16 . 18
						76. 29 . 12

Chronometer fast m. time { 5. 00 . 44, 24 / 5. 00 . 45, 47 } 5. 00 . 44, 85.

January 2d, A. M. Sun's L. L. Bar. 29, 98. *Th.* 32.

Chronometer.	Level.	Readings, &c.		Chronometer.	Level.	Readings, &c.
25. 42 . 11, 6	0 0			25. 53 . 45, 2	0 0	
43 . 31, 2	+ 3—6	18. 58 . 15	131. 35 . 30	55 . 22	0 0	235. 06 . 50
45 . 31, 2	0 0	00	5 . 20	57 . 00, 4	—2—10	07 . 00
47 . 02	+ 8 0	30	6 . 00	59 . 10, 4	0 0	07 . 30
49 . 46	—10 0	10	5 . 10	26. 00 . 33, 6	0 0	06. 50
50 . 56	+ 7—1	18. 58 . 14	131. 35 . 30	02 . 02	+7—1	235. 07 . 02,5
25. 46 . 29, 7	+18—17	341. 01 . 46	341. 01 . 46	25. 57 . 58, 93	+7—13	228. 24 . 30
20. 45 . 55, 3	+ 0 , 5		Level. 0.	20. 57 . 24. 1	—3.	Level —3.
5. 00 . 34, 4			472. 37 . 16	5. 00 . 34, 83		463. 31 . 30
		Obs. Z. D	78. 46 . 12, 7		Obs. Z. D.	77. 15 . 15
		Refr. — Par.	+ 4 . 46, 3		Refr. —Par.	+ 4 . 12
		Semid.	—16 . 18		Semid.	—16 . 18
		True Z. D.	78. 34 . 41		True Z. D.	77. 03 . 09

Chronometer fast m. time { 5. 00 . 34, 4 / 5. 00 . 34, 83 } 5. 00 . 34, 63.

January 2d, P. M. Sun's U. L. Bar. 30, 02. *Th.* 42.

Chronometer.	Level.	Readings, &c.		Chronometer.	Level.	Readings, &c.
8. 02 . 24, 4	+ 1—8			8. 14 . 51, 6	+ 2—5	
04 . 40, 4	+ 6—2	235. 06 . 50	331. 42 . 30	16 . 51, 2	+ 8+1	78. 17 . 50
06 . 22, 4	+ 7—1	6 . 40	2 . 10	18 . 55, 2	—10—3	17 . 40
07 . 52, 8	0 0	7 . 20	2 . 50	20 . 47, 6	+ 2– 5	18 . 20
09 . 29, 2	+ 7 0	6 . 50	2 . 00	22 . 41, 2	0—8	17 . 30
11 . 25, 6	0 0	235. 06 . 55	331. 42 . 22, 5	24 . 46	+ 6 -1	78. 17 . 50
8. 07 . 02, 47	+21—11	124. 53 . 05	124. 53 . 05	8. 19 . 48, 8	+19—32	28. 17 . 37,5
3. 06 . 29, 27	+5.		Level. +5	3. 19 . 16, 18	— 6, 5.	360.
5. 00 . 33, 2			456. 35 . 32	5. 00 . 32, 62		—6,5
		Obs. Z. D.	76. 05 . 55, 3			466. 35 . 21
		Refr. — Par.	+ 3 . 47, 5			77. 45 . 53
		Semid.	+16 . 18			+ 4 . 19
		True Z. D.	76. 26 . 01.			+16 . 18
						78. 06 . 38

Chronometer fast m. time { 5. 00 . 33, 2 / 5. 00 . 32, 62 } 5. 00 . 32, 91.

January 2d, α Lyræ West of the Meridian, Bar. 30, 02. *Th.* 32,5.

Chronometer.	Level.	Readings, &c.	
12. 02 . 50	0 0	180. 00 . 00	291. 50 . 00
04 . 24, 8	0 0	180. 00 . 00	50 . 00
07 . 24	0 0	180. 00 . 30	50 . 30
08 . 35, 2	+ 8—1	179. 59 . 30	49 . 30
11 . 32	— 9 0	180. 00 . 00	291. 50 . 00
12 . 55, 2	+ 5—4	180. 00 . 00	180. 00 . 00
12. 07 . 57, 53	+13—14		Level. 0.
7. 07 . 23, 47			471. 50 . 00
5. 00 . 34, 06	Chronometer fast m. time.		78. 38 . 20
			+ 4 . 53
			78. 43 . 13

January 2d, Rigel East of the Meridian, Bar. 30, 02. *Th.* 28.

Chronometer.	Level.	Readings, &c.		Chronometer.	Level.	Readings,&c.
12. 25 . 43, 2	+8—1			12. 38 . 39, 2	+ 6—3	
27 . 15, 2	0 0	291. 50 . 00	308. 01 . 45	40 . 01, 6	0 0	313. 26 . 10
28 . 39, 6	0 0	50 . 00	01 . 35	41 . 31, 2	+ 3—5	26 . 00
30 . 04, 4	0 0	50 . 30	02 . 15	42 . 43, 2	+ 6—2	26 . 30
31 . 57, 2	0 0	49 . 30	01 . 25	44 . 54, 4	+ 3—5	25 . 50
34 . 13, 6	0 0	291. 50 . 00	308. 01 . 45	47 . 40	0 0	313. 26 . 07,5
12. 29 . 38, 87	+8—1	68 10 . 00	68. 10 . 00	12. 42 . 34, 93	+18—1,5	Level +1,5
7. 29 . 04, 23	+3, 5		Level. +3	7. 41 . 59, 94	+1,5	51. 58 . 1,5
5. 00 . 34, 64			376 11 . 48	5. 00 . 34, 99		365 24 . 24
			62. 41 . 58			60. 54 . 04
		Refr.	1 . 57			+ 1 . 49
		True Z. D.	62. 43 . 58			60. 55 . 53

Chronometer fast m. time { 5. 00 . 34, 64 / 5. 00 . 34, 99 } 5. 00 . 34, 81.

January 3d, P. M. Sun's U. L. Bar. 30. 20. *Th.* 41.

Chronometer.	Level.	Readings, &c.	
8. 07 . 50	0 0		
09 . 16, 8	−2−10	120. 04 . 30	219. 43 . 10
10 . 54, 8	0 0	20	43 . 00
12 . 03, 2	+ 8 0	40	43 . 30
13 . 32	+10+2	10	42 . 50
18 . 31, 6	+10+2	120. 04 . 25	219. 43 . 07
8. 12 . 01, 4	+32−12	239. 55 . 35	239. 55 . 35
3. 11 . 30, 77	+10		Level +10
5. 00 . 30, 68	Chaonometer fast m. time.	Obs. Z. D.	459. 38 . 52
			76. 36 . 29
		Refr. — Par.	+ 3 . 57
		Semid.	+16 . 18
		True Z. D.	76. 56 . 44

January 3d, Sirius East of the Meridian, Bar. 30, 20. *Th.* 36, 5.

Chronometer.	Level.	Readings, &c.	
13. 33 . 42, 8	0 0		
35 . 08	0 0	272. 08 . 50	343. 24 . 00
36 . 36	0 0	08 . 50	24 . 00
39 . 06, 8	0 0	09 . 30	24 . 30
41 . 54	+2—6	08 . 30	23 . 30
43 . 15, 6	+2—7	272. 08 . 55	343. 24 . 00
13. 38 . 17, 2	+4—13	87. 51 . 05	87. 51 . 05
8. 27 . 44, 4	—3, 5		Level. —3, 5
5. 00 . 32, 8			431. 15 . 06, 5
		Obs. Z. D.	71. 52 . 31
		Refr.	+3 . 02
		True Z. D.	71. 55 . 33

Chronometer.	Level.	Readings, &c.
13. 46 . 24	+ 8—6	
48 . 26, 4	+ 2—8	43. 02 . 10
50 . 17, 6	+ 2—7	02 . 00
53 . 46, 8	0 0	02 . 35
57 . 05, 6	0 0	02 . 00
58 . 48	+ 9 0	43. 02 . 11
13. 52 . 28, 07	+16—21	16. 36 . 00
8. 51 . 54, 77	—2 , 5	360 00 . 00
5. 00 . 33, 3		Level - 2,5
		419. 38 . 09
		69. 56 . 21,5
		2 . 43,5
		69. 59 . 05

Chronometer fast m. time { 5. 00 . 32, 8 / 5. 00 . 33, 3 } 5. 00 . 33, 05.

Observations to determine the rate of No. 423, *between the* 24*th of December and the* 2*d of January, by the disappearance of stars behind the steeple of the Presbyterian Church, viewed in a Telescope fixed to the wall in the Eastern window of the Chapel of Columbia College.*

	Disappearance ob'sd by 423. December 24.	Disappearance ob'sd by 423. January 2d.	Difference.	Interval of sid. day.	Diff. between 9 Solar and sid. days.	423's less. In the Int'l	423's less. 6 sid. day.	423's less. 6 sol. day.
	h m s	h m s	m s		m s	s	s	s
(1) Ursæ Majoris.	12 . 11 . 35, 2	11 . 35 . 49, 6	35 . 45, 6	9	35 . 23, 19	22 , 41	2 , 49	2 , 5
(2) Ursæ Majoris.	12 . 15 . 16	11 . 39 . 29, 6	35 . 46, 4	9	35 . 23, 19	23 , 21	2 , 58	2 , 59
(3) Ursæ Majoris.	12 . 23 . 56, 8	11 . 48 . 10, 4	35 . 46,4	9	35 . 23, 19	23 , 21	2 , 58	2 , 59

RECAPITULATION OF THE RESULTS.

By the sun, west of the meridian.	December 22d, to January 2d, eleven days,	423 losing pr. diem.	2,5
- - - - - - - - - -	December 22d, to January 3d, twelve days,	- - - - -	2,62
- - - - - - - - - -	December 23d, to January 2d, ten days,	- - - - -	2,71
- - - - - - - - - -	December 23d, to January 3d, eleven days,	- - - - -	2,67
By the sun, east of the meridian.	December 24th, to January 2d, nine days,	- - - - -	2,59
By a lyræ west of the meridian.	December 22d, to January 2d, eleven days,	- - - -	2,59
By rigel east of the meridian.	December 23d, to January 2d, ten days,	- - - - -	2,67
By rigel & sirius east of the meridian.	December 23d, to January 3d, eleven days,	- - - - -	2,59
By the disappearance of stars No. 1.	December 24th, to January 2d, nine days,	- - - - -	2, 5
- - - - - - - - No. 2.	December 24th, to January 2d, nine days,	- - - - -	2,59
- - - - - - - - No. 3.	December 24th, to January 2d, nine days,	- - - - -	2,59
	Mean loss of the Chronometer per diem,	- - - - -	2,615

INTERMEDIATE.

By the sun, east of the meridian.	December 24th, to December 29th, five days,	423 loss pr. diem	2,62
- - - - - - - - - -	December 29th, to January 2d, four days,	- - - - -	2,56

Comparisons of the Astronomical Clock with the Chronometer No. 423, at Columbia College, New-York, between the 22d of December, 1822, and the 3d of January, 1823, with the clock's rate deduced therefrom.

DATE.	Chronometer. s. Losing 2, 515 per diem.	Clock.	Clock's daily rate, losing			
			On the Chronometer.			On Solar Time.
	h. m. s.	h. m. s.	s.			
December 22.	7 . 00 . 00	8 . 50 . 02, 9				
23.	7 . 00 . 00	8 . 49 . 32, 3	30, 6			
24.	7 . 00 . 00	8 . 49 . 02	30, 3	s.		
25.	7 . 00 . 00	8 . 48 . 31, 6	30, 4	29, 98		
26.	7 . 00 . 00	8 . 48 . 02	29, 6			
27.	7 . 00 . 00	8 . 47 . 33	29		s.	s.
28.	7 . 00 . 00	8 . 47 . 03	30		30, 017	32, 632
29.	7 . 00 . 00	8 . 46 . 33, 1	29, 9			
30.	7 . 00 . 00	8 . 46 . 03, 2	29, 9			
31.	7 . 00 . 00	8 . 45 . 34, 2	29	30, 04		
January 1.	7 . 00 . 00	8 . 45 . 04	30, 2			
2.	7 . 00 . 00	8 . 44 . 34	30			
3.	7 . 00 . 00	8 . 44 . 02, 7	31, 3			

The clock had been going from the 14th of December, but the account was not commenced until the weather permitted the use of the repeating circle on the 22d.

The clock, therefore, appears to have lost, on mean solar time, 32.632 seconds per diem, between the 22d of December and the 3d of January, and to have made, consequently, 86367.368 vibrations in a mean solar day. The very near agreement of the several particular results from whence the final deduction is derived, together with the number of days which comprise the interval, and by which, of course, any errors in the commencement and close (being the only errors which can affect the conclusion) are divided, justify a belief in the correctness of the determination.

It would appear, also, that if this interval be divided into two portions, i. e. from the 22d of December to the 27th, and from the 27th to the 3d of January, the rate of the clock may be considered to have been the same in both portions, although this conclusion cannot be deemed so precise as the former, and may admit of a doubt, amounting to one tenth of a second in the twenty-four hours; it will be evident, however, that if the rate assigned to the one portion be in defect to that amount, it will be in a corresponding excess in the other, and that if the two portions of time be used as separate intervals, each for a distinct series of experiments with an invariable pendulum, the errors thus supposed in the assignment will mutually destroy each other in the mean of the results obtained by the two series; and it will be further evident, that if a second invariable pendulum be employed in the second series, instead of the same in both, the rate of the one may be in defect, and of the other in excess; but their mean result will be the same as if the assignment had been precisely correct; or at least there will be no sensible difference.

The principal advantage of using two pendulums is to show, by the accordance of their result (within the limits of the above assignment,) that they have sustained no injury or alteration in the removal from station to station, but they also afford, incidentally, an evidence that the experiments at each station were sufficiently extended, when the result of each pendulum, separately, agrees, within the aforesaid limits, with their combined results.

The pendulums which I employed were similar in all respects, except in a very trifling difference in length, equivalent, on an average of nine series of experiments with each, to nine seconds and seven tenths per diem; they were numbered 3 and 4, for distinction.

In the observations of coincidences I had the pleasure and advantage of the co-operation of Mr. Renwick, professor of Natural Philosophy and Chemistry in Columbia College; whose interest in the subject induced him to associate himself with me throughout the experiments; a circumstance extremely agreeable to me, and advantageous to the results.

In the following tables, which contain these observations, those of the first day only are given at full length; on the others, the first, and eleventh, or last, coincidence only are entered, as these comprise the ten intervals from the mean of which the rate of the pendulum is inferred: the intermediate coincidences were frequently unnoticed in the observations to which my own name is affixed, the room being left undisturbed in preference: but they were always observed in Mr. Renwick's, for the advantage of practice.

The correction for the arc of vibration in these tables is computed by multiplying the square of the mean observed arc by the difference between the number of vibrations made by the pendulum in twenty-four hours in a cycloid and in a circular arc of one degree, and being added to the observed number of vibrations in twenty-four hours, shows what they would have been in an arc infinitely small; it may be remarked, of this correction, that care having been taken that the pendulums should vibrate as nearly as possible in the same arcs in London and in New-York, it is not important that the mode of computation should be rigorously exact.

OBSERVATIONS OF COINCIDENCES, AT COLUMBIA COLLEGE, NEW-YORK.

Pendulum No. 3.

1822, *December 23d, A. M. Observer Capt. Sabine: Bar. 30, 14; Clock making 86,367,368 vib. in a m. solar day.*

Tem.	Times of Coincidence. Disapp. h.	m.	s.	Reapp. m.	s.	Mean m.	s.	Arc. of Vib. °	Mean Arc. °	Interval in seconds.	Obs'd Vibrations in 24 hours.	Corr'tion for arc.	Vibrations in 24 hours.
°												s.	
40,3	10.	33 .	49	33 .	53	33 .	51	1 , 18					
		45 .	09	45 .	16	45 .	12,5	1 , 10	1 , 14	681,5		2,173	
		56 .	31	56 .	39	56 .	35	1 , 04	1 , 07	682,5		1,378	
	11.	07 .	54	08 .	04	07 .	59	0 , 98	1 , 01	684		1,673	
		12 .	17	19 .	97	19 .	22	0 , 92	0 , 95	683		1,484	
		30 .	40	30 .	52	30 .	46	0 , 86	0 , 89	684		1,299	
		42 .	06	42 .	16	42 .	11	0 , 8	0 , 83	685		1,129	
		53 .	31	53 .	41	53 .	36	0 , 74	0 , 77	685		0,972	
	12.	04 .	56	05 .	06	05 .	01	0 , 68	0 , 71	685		0,828	
		16 .	21	16 .	32	16 .	26	0 , 62	0 , 65	685,5		0,691	
40,1		27 .	46	27 .	59	27 .	52,5	0 , 58	0 , 6	686		0,577	
40,2	Mean of ten Intervals.									664,15	86114,88	1,27	86116,15

December 23d, P. M. Observer Professor Renwick; Bar. 30, 26; Clock making 86,367,368 vib. in a m. solar day.

40,3	1.	40 .	00	40 .	06	40 .	03	1 , 20					
		51 .	22	51 .	29	51 .	25,5	1 , 12	1 , 16	682,5		2,192	
	2.	02 .	45	02 .	54	02 .	49,5	1 , 04	1 , 08	684		1,893	
		14 .	07	14 .	17	14 .	12	0 , 98	1 , 01	682,5		1,673	
		25 .	29	25 .	39	25 .	34	0 , 92	0 , 95	682		1,484	
		36 .	52	37 .	05	36 .	58,5	0 , 86	0 , 89	684,5		1,299	
		48 .	17	48 .	28	48 .	22,5	0 , 79	0 , 83	684		1,129	
		59 .	41	59 .	53	59 .	47	0 , 74	0 , 76	684,5		0,947	
	3.	11 .	06	11 .	17	11 .	11,5	0 , 68	0 , 715	684,5		0,838	
		22 .	32	22 .	45	22 .	38,5	0 , 62	0 , 65	687		0,691	
40,2		33 .	56	34 .	15	34 .	05,5	0 , 58	0 , 6	687		0,577	
40,25	Mean of ten Intervals.									684,25	86114,9	1,272	86116,172

December 24th, A. M. Observer, Capt. Sabine, Bar. 30, 40, Clock making 86,367,368 vib. in a m. solar day.

Temp.	No. of Coincidence.	Times of coincidence. Disap.	Reapp.	Mean.	Arc of vib.	Mean Arc.	Interval in sec'ds.	Observed vib. in 24 hours.	Correction for Arc.	Vibration in 24 hours.
33,7	1st.	9.11.02	11.05	11.03,5	1,2					
34,3	11th.	11.06.06	06.21	06.13,5	0,58					
34	Mean of ten intervals.						691	86117,38	1,272	86118,652

December 24th, noon; Observer Capt. Sabine; Bar. 30, 40; Clock making 86,367,368 vib. in a m. solar day.

34,75	1st.	11.28.50	28.54	28.52	1.18					
36,25	11th.	1.23.36	23.47	23.41,5	0.6					
35,5	Mean of ten Intervals.						688,95	86116,62	1,272	86117,892

December 24th, P. M. Observer Professor Renwick; Bar. 30, 40; Clock making 86,367,368 vib. in a m. solar day.

36,8	1st.	1.35.41	35.45	35.43	1,26					
36,3	11th.	3.30.01	30.21	30.11	0,66					
36,55	Mean of ten Intervals.						686,8	86115,86	1,529	86117,389

December 25th, A. M. Observer Capt. Sabine; Bar. 30, 12; Clock making 86,367,368 vib. in a m. solar day.

32,9	1st.	10.41.43	41.47	41.45	1,2					
33,6	11th.	12.36.49	37.04	36.56,5	0,60					
33,25	Mean of ten Intervals.						691,15	86117,44	1,28	86118,72

December 25th, P. M. Observer Professor Renwick; Bar. 30, 00; Clock making 86,367,368 vib. in a m. solar day,

33,5	1st.	12.59.30	59.37	59.33,5	1,21					
35,6	11th.	2.54.27	54.48	54.37,5	0,58					
34,55	Mean of ten Intervals.						690,4	86117,16	1,279	86118,439

December 26th, A. M. Observer Capt. Sabine; Bar. 30, 00; Clock making 86,367,368; vib. in a m. solar day.

32,6	1st.	10.51.20	51.25	51.22,5	1,2					
33	11th.	12.46.37	46.49	46.43	0,6					
32,8	Mean of ten Intervals.						692,05	86117,76	1,28	86119,04

December 26th, P. M. Observer Professor Renwick; Bar. 30, 18; Clock making 86,367,368 vib. in a m. solar day.

33,1	1st.	12.58.26	58.30	58.28	1,24					
34,6	11th.	2.53.31	53.52	53.41,5	0,59					
33,85	Mean of ten Intervals.						691,35	86117,5	1,375	86118,875

Pendulum No. 4.

December 27th, A. M. Observer, Capt. Sabine; Bar. 30, 42; Clock making 86367,368 vib. in a m. solar day.

Temp.	No. of Coincidence.	Times of coincidence. Disap.	Reapp.	Mean.	Arc of vib.	Mean Arc.	Interval in sec'ds.	Observed vib. in 24 hours.	Correction for Arc.	Vibration in 24 hours.
32,7	1*st.*	11.11.33	11 . 39	11 . 36,	1,18					
32,3	11*th.*	01.11.23	11 . 40	11 . 51,5	0,58					
32,5	Mean of ten intervals.						719,55	86127,3	1,27	86128,57

December 27th, P. M. Observer Professor Renwick; Bar. 30, 42; Clock making 86367,368 vib. in a m. solar day.

32,4	1*st.*	1.22.57	23 . 04	23 . 00,5	1 . 24					
32,8	11*th.*	3.22.39	23 . 10	22 . 54,5	0 . 59					
32,6	Mean of ten Intervals.						719,4	86127,26	1,375	86128,635

December 28th, A. M. Observer Professor Renwick; Bar. 30, 29; Clock making 86367,368 vib. in a m. solar day.

32,6	1*st.*	10.13.22	13 . 24	13 . 23	1 , 3					
33	11*th.*	12.12.59	13 . 26	13 . 13,5	0 , 62					
32,8	Mean of ten Intervals.						719,05	86127,12	1,48	86128,6

December 28th, P. M. Observer Professor Renwick; Bar. 30, 29; Clock making 86367,368 vib. in a m. solar day.

33,1	1*st.*	12.36.43	36 . 48	36 . 45,5	1 , 24					
32,9	11*th.*	2.36.25	36 . 49	36 . 37	0 , 58					
33,	Mean of ten Intervals.						719,15	86127,16	1,37	86128,53

December 29th, A. M. Observer Capt. Sabine; Bar. 30, 29; Clock making 86367,368 vib. in a m. solar day

32	1*st.*	9.07.22	07 . 30	07 . 26	1 , 14					
33,7	11*th.*	11.07.20	07 . 34	07 . 27	0 , 58					
32,85	Mean of ten Intervals.						720,1	86127,46	1,14	86128,6

December 29th, P. M. Observer Professor Renwick; Bar. 30, 29; Clock making 86367,368 vib. in a m. solar day.

35	1*st.*	11.30.32	30 . 39	30 . 35,5	1 , 24					
36,5	11*th.*	1.29.52	30 . 10	30 . 01	0 , 6					
35,75	Mean of ten Intervals.						716,55	86126,28	1,37	86127,65

December 30th, A. M. Observer Professor Renwick; Bar. 30, 46; Clock making 86367,368 vib. in a m. solar day.

33,4	1*st.*	10.03.35	03 . 40	03 . 37, 5	1 , 28					
35,1	11*th.*	12.03.03	03 . 29	03 . 17	0 , 6					
34,25	Mean of ten Intervals.						717,95	86126,76	1,43	86128,19

December 30th, P. M. Observer, Professor Kenwick; Bar. 30, 56; Clock making 86367,368 vib. in a m. solar day.

Temp.	No. of Coincidence.	Times of coincidence. Disap.	Reapp.	Mean.	Arc of vib.	Mean Arc.	Interval in sec'ds.	Observed vib. in 24 hours.	Correction for Arc	Vibration in 24 hours.
35,3	1st	12.25.16	25.22	25.19	1,23					
36,6	11th	2.24.26	24.46	24.36	0,61					
35,95	Mean of ten intervals.						715,7	86126	1,37	86127,37

December 31st, P. M. Observer, Professor Renwick; Bar. 30, 79; Clock making 86367,368, vib. in a m. solar day.

33	1st	12.47.02	47.09	47.05,5	1,2					
34,2	11th	2.46.35	46.57	46.46	0,59					
33,6	Mean of ten intervals.						718,05	86126,78	1,275	86128,055

1823, January 1st, noon, Observer Capt. Sabine; Bar. 30, 51; Clock making 86367,368 vib. in a m. solar day.

31,2	1st	11.31.44	31.53	31.48,5	1,18					
31,2	11th	1.31.52	32.10	32.01	0,6					
31,2	Mean of ten intervals.						721,25	86127,86	1,28	86129,14

January 2d, A. M. Observer, Capt. Sabine; Bar. 29, 98; Clock making 86367,368 vib. in a m. solar day.

33,3	1st	9.15.33	15.39	15.36	1,2					
35,7	11th	11.15.10	15.26	15.18	0,6					
34,5	Mean of ten intervals.						718,2	86126,84	1,28	86128,12

January 2d. P. M. Observer Professor Renwick; Bar. 30, 02; Clock making 86367,368 vib. in a m. solar day.

36,2	1st	12.21.01	21.02	21.01,5	1,29					
37,3	11th	2.20.05	20.26		0,61					
36,75	Mean of ten intervals.						715,4	86125,9	1,48	86127,38

In the next Table, on which the results of the preceding observations are collected in one view, and reduced to a mean, is shown, *first*, the number of vibrations of each pendulum at the observed temperature and under the observed atmospheric pressure: *secondly*, the number which it is presumed would have been made had the temperature been 53 degrees, at which the corresponding experiments were made in London; this number is reduced on the supposition (of which more will be said in the sequel) that one degree of Fahrenheit's scale occasions an alteration of $\frac{435}{10000}$ of a vibration, in the rate per diem; and *lastly*, the vibrations at 53 degrees are reduced to a vacuum

and to the level of the sea; the first of these reductions being computed by the usual and well known method, and the second on the consideration, unmodified, of the force of gravity decreasing as the square of the distance from the earth's centre increases.

The height of the pendulum above the sea was estimated as is shown in the following detail.

A station in Murray-street 75 feet East of Chapel-street, as appears in the survey of the city, is above high water	20. 8 feet
The half rise of the mean tide between the Spring and neap, is estimated at	2, 5
The rise from the station in Murray-street to the ground line of Columbia College estimated	14
The pendulum above the ground line estimated	30
Total height above half tide	67 feet

Vibrations of the detached Pendulums at Columbia College, New-York, Lat. 40° 42′ 43″ N.; Elevation 67 feet above high tide.

Pendulum 3.

1822.	Barom.	Vibrations in 24 hours.	Mean Temp.	Corr. to Temperat. 55 deg.	Vibrations in 24 hours at Temperat. 55 degrees.	Corrections. Buoyancy	Corrections. Elevation	Vib. in a m. solar day, in a vacuum at the level of the sea.
December	In.		°	″				Temp. 58°.
23, A.M.	30, 14	86116.15	40.2	5.504	86110.646			
,, P.M.	30, 26	86116.172	40.25	5.482	86110.69			
24, A.M.	30, 40	86118.652	34	8.17	86110.482			
,, Noon	30, 40	86117.892	35.5	7.525	86110.367			
,, P.M.	30, 40	86117.389	36.55	7.073	86110.316			
25, A.M.	30, 12	86118.72	33.25	8.492	86110.228			
,, P.M.	30, 00	86118.439	34.55	7.933	86110.506			
26, A.M.	30, 00	86119.04	32.8	8.686	86110.354			
,, P.M.	30, 18	86118.875	33.85	8.234	86110.641			
Means,	30, 21	86117.925	35.66	7.456	86110.47	6,418	0,276	86117.164

Pendulum 4.

1823.	Barom.	Vibrations in 24 hours.	Mean Temp.	Corr. to Temperat. 53 deg.	Vibrations in 24 hours at Temperat. 53 degrees.	Corrections.		Var. in a m. solar day, in a vacuum at the level of the sea.
						Buoyancy	Elevation	
December	In.		°	s				Temp. 53°.
27, A.M.	30.42	86128·57	32·5	8.815	86119.755			
„ P.M.	30.42	86128.635	32.6	8.772	86119.863			
28, A.M.	30.29	86128.6	32.8	8.686	86119.914			
„ P.M.	30.29	86128.53	33	8.6	86119.93			
29, A.M.	30·29	86128.6	32.85	8.664	86119.936			
„ P.M.	30.29	86127.65	35.75	7.417	86120·233			
30, A.M.	30.46	86128.19	34.25	8.062	86120.128			
„ P.M.	30.56	86127.37	35·95	7.331	86120.039			
31, P.M.	30.79	86128.055	33.6	8.344	86119.711			
1823. January 1, Noon,	30.51	86129·14	31.2	9.374	86119.766			
2, A.M.	29.98	86128.12	34.5	7.955	86120.165			
„ P.M.	30.02	86127.38	36.75	6.987	86120.393			
Means.	30.36	86128.237	33.81	8.251	86119.986	6,47	0,276	86126.732

Latitude of Columbia College.

A knowledge of the Latitude is not necessary in the deduction of the length of the pendulum; but as it is an important datum in connexion with it, for several purposes, it may be desirable to annex the following observations made in the Cupola of Columbia College towards its determination by Meridian Zenith Distances of the Sun and Stars, obtained with the Repeating Circle already mentioned.

The mean result does not differ, it is understood, more than 1 or 2 seconds from that of unpublished observations of Professor Adrain.

Meridian Zenith Distances of the Sun and Stars, observed in the Cupola of Columbia College, New-York, with a Repeating Circle, for the purpose of determining the Latitude. Long. 74. 03½ west of Greenwich.

December 24th, 1822, *Bar.* 30, 40, *Therm.* 20, 5; *the Chronometer* 423 *fast of mean time* 5*h.* 00*m.* 75*s.*; *mean time of apparent noon* 23, 59, 58: *Sun on the meridian at* 5*h.* 00*m.* 50*s. by* 423.

Chronometer.	Level.		Time from the merid.	N. V. Sines.
4 . 45 . 27	0	0	15 . 23	2252
49 . 06	0	0	11 . 44	1310
51 . 50	+ 3	− 7	9 . 00	771
57 . 23	+ 2	− 7	3 . 27	113
59 . 40	0	−10	1 . 10	13
5 . 03 . 10	+ 9	0	2 . 20	52
05 . 25	+ 7	− 3	4 . 35	200
07 . 10	0	0	6 . 20	382
09 . 10	+ 6	− 4	8 . 20	661
10 . 38	+ 7	− 3	9 . 48	914
12 . 54	+ 8	− 3	12 . 04	1386
15 . 00	+ 8	− 2	14 . 10	1910
	+50	−39		830, 3
	+5, 5			

Readings, &c.				
For the Zero.	Final.	Lat.	40. 42. 43.	Cos. 9.8796683
328. 26. 20	21. 34. 50			
20	4. 30	Dec.	23.26.34.	Cos. 9.9625861
50	5. 10			
00	4. 30	L.D.	64.09.15.	Co-sec. 0.0457718
328. 26. 22,5	21. 34. 45			
31. 33. 37,5	31. 33. 37,5	Log. sin.	1″.	Co-ar. 5.3144251
	720			
	Level +5,5			Const. Log. 5.2024513
	773. 08. 28			
Obs. Zen. Dist.	64. 25. 42,3	Log. 830, 3	(+4)	6.9192350
Refr. −Par.	+2. 02,4			
Semid.	−16. 17,6	Corr.	2′. 12″,3	2.1216863
Corr.	−2. 12,3			
True mer. Zen. Dist.	64. 09. 14,8			
Declin.	23. 26. 33,8			
Latitude	40. 42. 41 N.			

December 24th, Bar. 30, 40; *Therm.* 21; 423 *fast of mean time* 5*h.* 00*m.* 56*s.*; *the Sidereal Chron.* 702 *fast of* 423 7*h.* 36*m.* 52*s. at* 11*h.* 47. *by* 423; *the Pole Star* (*AR* 0. 57. 46, 3) *on the meridian at* 19*h.* 23*m.* 51*s. by* 702.

Chronometer.	Level.		Time from the merid.	N. V. sines.
19 . 09 . 48	0	0	14 . 03	1879
13 . 13	+11	0	10 . 38	1076
15 . 32	0	0	8 . 19	658
16 . 52	0	0	6 . 59	464
19 . 02	−11	− 1	4 . 49	221
20 . 48	+10	+ 1	3 . 03	89
23 . 12	+ 8	− 4	0 . 39	4
25 . 14	− 9	− 1	1 . 23	18
30 . 37	0	0	6 . 46	436
33 . 00	+ 9	+ 2	9 . 09	797
35 . 08	+ 8	− 4	11 . 17	1212
37 . 09,5	+ 9	− 2	13 . 18	1683
	+58	−32		711, 4
	+13			

Readings, &c.				
For the Zero.	Final.	Lat.	40.42.43.	Cos. 9.8796683
228. 56. 30	80. 37. 40			
56. 20	37. 00	Dec.	88.22.18.	Cos. 8.4535622
57. 00	38. 10			
56. 30	37. 30	Z.D.	47.39.31	Co-sec. 0.1312705
228. 56. 35	80. 37. 35			
131. 03. 25	131. 03. 25	Log. sin.	1″.	Co-ar. 5.3144251
	360.			
	Level+13			Const. Log. 3.7789261
	571. 41. 13			
Obs. Z. D.	47. 38. 26,1	Log. 711.4	(+4)	6.8521139
Refr.	+1. 09,3			
Corr.	−0. 04,3	Corr.	4″.3	0.6310400
True mer. Z.D.	47. 39. 31,1			
Stars Declin.	88. 22. 18,3			
Latitude	40. 42. 47,2 N.			

December 31*st*, *Barom.* 30, 76; *Therm.* 26; *Chronometer* 423 *fast of mean time* 5*h.* 00*m.* 40*s*; *mean time of appa-*
re .. *',* 0*h* 3*m.* 19*s.*; *Sun on the meridian at* 5*h.* 03*m.* 59*s. by* 423.

Chronometer	Level.		Time from the merid.	N. V. sines.
4.49.13	0	0	14.46	2075
52.12	− 9	0	11.47	1321
54.26	+ 7	− 2	9.33	868
56.45	+12	+ 3	7.14	498
59.20	+9	0	4.39	206
5.00.47	+6	− 4	3.12	97
02.45	−3	−12	1.14	14
04.44	0	0	0.45	5
07.00	+3	− 7	3.01	87
08.32	0	− 9	4.33	197
10.52	+10	0	6.53	451
13.24	+10	0	9.25	844
	+60	−46		555,25
	+7			

Readings, &c.

For the Zero.	Final.			
128.22.40	177.31.50	Lat.	40.42.43.	Cos. 9.8796683
2.20	1.40	Dec.	23.07.17,5	Cos. 9.9636344
3.10	2.00			
2.20	1.20	Z.D.	63.50.00	Co-sec. 0.0469582
128.22.37,5	177.31.42,5			
231.37.22,5	231.37.22,5	Log. sin.	1″.	Co-ar. 5.3144251
	360			
	Level +7			Const. Log. 5.2046860
	769.09.12			
Obs. Z. D.	64.05.46	Log. 555,25	(+4)	6.7444886
Refr.—Par.	+ 2.00,1			
Semid.—	16.17,8			
Corr.—	1.28,95	Corr.	1′.28″,95	1.9491746
True mer. Z.D.	63.49.57,35			
Declin.	23.07.17,5			
Latitude	40.42.41,85 N.			

January 3*d*, 1823; *Bar.* 30, 20; *Ther.* 36; 423, *fast of mean time* 5*h.* 00*m.* 33*s*; *the Sidereal Chronometer* 702 *fast of* 423, 7*h.* 15*m* 51*s. at* 13*h.* 00*m. by* 423; *β. Ursæ Minoris* (*AR* 14*h.* 51*m.* 17*s*,5.) *on the meridian below the Pole at* 20*h.* 16*m.* 22*s. by* 702.

Chronometer.	Level.		Time from the merid.	N. V sines.
20.05.40	0	0	10.42	1090
08.18	+ 3	− 6	8.04	619
11.00	0	0	5.22	274
12.32	0	0	3.50	140
16.36,5	−10	0	0.14	1
20.57	− 9	0	4.35	200
24.14,5	−10	0	7.52	589
26.12,5	+ 2	− 7	9.50	920
28.02	+10	0	11.40	1295
29.53,5	+ 3	− 6	13.31	1739
32.06,5	0	0	15.44	2355
34.55	− 9	0	18.33	3274
	+18	−57		1041,3
	−19,5			

Readings, &c.

For the Zero.	Final			
219.43.00	272.08.50	Lat.	40.42.43.	Cos. 9.8796683
43.10	08.50	Dec.	74.52.18,9	Cos. 9.4166026
43.25	09.30			
42.50	08.30	Z.D.	64.25.00	Co-sec. 0.0448136
219.43.06,2	272.08.55			
140.16.53,8	140.16.53,8	Log. sin.	1″.	Co-ar. 5.3144251
	360			Const. Log. 4.6555096
	Level —19,5			
	772.25.29,3	Log. 1041,3	(+4)	7.0175759
Obs. Z. D.	64.22.07,44			
Refr.	+2.04,7			
Corr.	+0.47,11	Corr.	47″,11	1.6730855
True mer. Z.D.	64.24.59,25			
Pol. Dist.	−15.07.41,1			
Co-Lat.	49.17.18,15			
Latitude	40.42.41,85 N.			

RESULTS.

December 24th, By the Sun - - - - - - -	40° 42′ 41″
December 24th, By the Pole Star - - - -	40. 42. 47,2
December 31st, By the Sun - - - - - - -	40. 42. 41,85
January 3d, By B. Urs. Min. below the Pole	40. 42. 41,85
Mean - -	40. 42. 43, North.

EXPERIMENTS IN LONDON.

The corresponding experiments in London were made in March and in the beginning of April, 1823, in the house of Henry Browne, Esq. F. R. S. in Portland Place, in the same room in which Captain Kater determined the length of the pendulum in 1817. The same agate support for the knife-edge of the pendulum which had been used at New-York, was here firmly screwed to the mahogany plank which had supported Captain Kater's pendulum; every other part of the apparatus used in London, was the same as at New-York, except the Astronomical Clock, which of course is immaterial to the result; the general temperature of the apartment underwent much the same variation in amount in the course of the 24 hours as at New-York, except on the 11th and 13th of March, when the room was purposely heated by charcoal, in order to obtain results at a considerable difference of temperature.

The rate of the clock was supplied by Mr. Browne, from its comparison with two other clocks of great excellence; one of which, by Cumming, is well known by its service in former pendulum experiments, and the other has been recently made on the same construction by Mr. Molyneux, and has proved not inferior to the original: these clocks are regularly compared with Astronomical time, by a transit instrument. The clock used in the observations of coincidences was made by Bolton, and its rate during the period in which they were continued, was deduced as follows.

1823.	Rate of Bolton deduced from		Mean Rate Gaining.
	Cumming.	Molyneux.	
February 27th, midnight.			
28th,	+0, 43	+0, 43	0, 43
March 1st,	0, 75	0, 73	0, 74
2	0, 3	0, 2	0, 25
3	0, 45	0, 6	0, 52
4	0, 55	0, 4	0, 47
5	0, 38	0, 4	0, 39
6	0, 38	0, 2	0, 29
7	0, 6	0, 6	0, 6
8	0, 8	0, 8	0, 8
9	0, 8	0, 8	0, 8
10	0, 3	0, 2	0, 25
11	0, 3	0, 2	0, 25
12	0, 00	0, 00	0, 00
13	0, 35	0, 35	0, 35
14	0, 00	0, 00	0, 00
15	0, 5	0, 4	0, 45
16	0, 6	0, 4	0, 5
17	0, 5	0, 5	0, 5
18			
19	0, 6	0, 6	0, 6
20	0, 7	0, 6	0, 65
21	0, 8	0, 9	0, 85
22	0, 5	0, 8	0, 65
23	0, 3	0, 3	0, 3
24	0, 1	0, 1	0, 1
25	0, 2	0, 2	0, 2
26	0, 2	0, 1	0, 15
April 4			Losing
5	0, 15	0, 15	0, 15
6	0, 15	0, 15	0, 15

OBSERVATIONS OF COINCIDENCES IN LONDON.

Pendulum 3d.

1823, *March 19th, A. M.; Bar.* 29, 75; *Clock making* 86400,6 *vibrations in a m. solar day.*

Temp.	Times of coincidence. Disap.	Reapp.	Mean.	Arc of vib.	Mean Arc.	Interval in sec'ds.	Observed vib. in 24 hours.	Corrections for Arc.	Vibrations in 24 hours.
53,5	11.24.57	11.25.02	11.24.59,5	1.28					
	36.25	36.30	36.27,5	1.2	1.24	688		2.524	
	47.53	48.00	47.56,5	1.12	1.16	689		2.192	
	59.23	59.30	59.26,5	1.04	1.08	690		1.893	
	12.10.54	12.11.01	12.10.57,5	0.96	1.0	691		1.64	
	22.25	22.34	22.29,5	0.9	0.93	692		1.426	
	33.57	34.06	34.01,5	0.84	0.87	692		1.249	
	45.30	45.39	45.34,5	0.78	0.81	693		1.076	
	57.03	57.13	57.08	0.72	0.75	693,5		0.922	
	1.08.36	1.08.47	1.08.41,5	0.68	0.7	693,5		0.804	
53,7	20.10	20.21	20.15,5	0.64	0.66	694		0.714	
53,6	Mean of ten intervals.					691,6	86150,76	1.44	86152,2

March 19th, P. M.; Bar. 29, 75; *Clock making* 86400,6 *vibrations in a m. solar day.*

53,7	2.53.51	2.53.58	2.53.54,5	1.28					
53,5	4.49.03	4.49.18	4.49.10,5	0.64					
53,6	Mean of ten intervals.					691,6	86150,76	1.44	86152,2

March 20th, A. M.; Bar. 29, 60; *Clock making* 86400,65 *vibrations in a m. solar day.*

51,2	11.17.23	11.17.28	11.17.25,5	1.28					
50,9	1.13.06	1.13.15	1.13.10,5	0.64					
51,05	Mean of ten intervals.					694,5	86151,85	1.44	86153,29

March 20th, P. M.; Bar. 29, 60; *Clock making* 86400,65 *vibrations in a m. solar day.*

51	2.30.33	2.30.41	2.30.37	1.26					
51	4.26.23	4.26.34	4.26.28,5	0.64					
51	Mean of ten intervals.					695,15	86152,06	1.43	86153,49

March 21st, Noon; Bar. 29, 25; *Clock making* 86400,85 *vibrations in a m. solar day.*

55	12.18.16	12.18.22	12.18.19	1.3					
54,7	2.13.14	2.13.32	2.13.23	0.66					
54,85	Mean of ten intervals.					690,4	86150,56	1,46	86152,02

March 22d, A. M.; Bar. 29, 15; Clock making 86400,65 vibrations in a m. solar day.

Temp.	Times of coincidence. Disap.	Reapp.	Mean.	Arc of vib.	Mean Arc.	Interval in sec'ds.	Observed vib. in 24 hours.	Corrections for Arc	Vibration in 24 hours.
54, 4	10.52.09	10.52.14	10.52.11,5	1.3					
54, 6	12.47.20	10.47.30	10.47.25	0.66					
54, 5	Mean of ten intervals.					691, 35	86150, 7	1 . 46	86152, 16

March 22d, P. M.; Bar. 29, 15; Clock making 86400,65 vibrations in a m. solar day.

54, 7	1.58.01	1.58.06	1.58.03,5	1.22					
54, 9	3.53.14	3.53.26	3.53.20	0.62					
54, 8	Mean of ten intervals.					691, 65	86150, 8	1 . 29	86152, 09

March 24th, P. M.; Bar. 30, 20; Clock making 86400,1 vibrations in a m. solar day.

55	1.56.32	1.56.38	1.56.35	1.2					
54, 5	3.51.52	3.52.05	3.51.58,5	0.6					
54, 75	Mean of ten intervals.					692, 35	86150, 5	1 . 27	86151, 77

March 25, A. M.; Bar. 30, 30; Clock making 86400,2 vibrations in a m. solar day.

53	11.23.01	11.23.09	11.23.05	1.22					
54	1.18.31	1.18.45	1.18.38	0.6					
53, 5	Mean of ten intervals.					693, 3	86150, 96	1 . 28	86152, 24

Pendulum 4th.

1. 1823, *March 4th, A. M.; Bar. 29, 30; Clock making 86400,47 vibrations in a m. solar day.*

53	10.55.06	10.55.11	10.55.08,5	1.18					
52, 8	12.55.25	12.55.37	12.55.31	0.6					
52, 9	Mean of ten intervals.					722, 25	86161,257	1 , 27	86162,527

2. *March 4th, P. M.; Bar. 29, 35; Clock making 86400.47 vibrations in a m. solar day.*

52, 8	1.19.24	1.19.31	1.19.27,5	1.24					
53	3.19.44	3.19.56	3.19.50	0.6					
52, 9	Mean of ten intervals.					722, 25	86161,257	1 , 375	86162,632

3. *March 5th, A. M.; Bar. 29, 45; Clock making 86400,39 vibrations in a m. solar day.*

51, 6	11.45.16	11.45.25	11.45.20,5	1.18					
52	1.45.53	1.46.04	1.45.58,5	0.6					
51, 8	Mean of ten intervals.					723, 8	86161, 64	1 , 27	86162, 91

4. *March 5th, P. M.*; *Bar.* 29, 50; *Clock making* 86400,39 *vibrations in a m. solar day.*

Temp.	Times of coincidence. Disap.	Reapp.	Mean.	Arc of vib.	Mean Arc.	Interval in sec'ds.	Observed vib. in 24 hours.	Corrections for Arc.	Vibration in 24 hours.
52	1.58.31	1.58.37	1.58.34	1.2					
52,7	3.58.56	3.59.14	3.59.05	0.6					
52,35	Mean of ten intervals.					723,1	86161,41	1,27	86162,68

5. *March 6th, A. M.*; *Bar.* 29, 75; *Clock making* 86400,29 *vibrations in a m. solar day.*

52	11.52.11	11.52.17	11.52.14	1.24					
52	1.52.40	1.52.58	1.52.49	0.62					
52	Mean of ten intervals.					723,5	86161,43	1,38	86162,81

6. *March 23d, A. M.*; *Bar.* 29, 65; *Clock making* 86400, *vibrations in a m. solar day.*

54,5	11.50.32	11.50.39	11.50.35,5	1.24					
55	1.50.18	1.50.31	1.50.24,5	0.62					
54,75	Mean of ten intervals.					719,4	86160,1	1,38	86161,48

7. *March 23d, P. M.*; *Bar.* 29, 65; *Clock making* 86400,3 *vibrations in a m. solar day.*

55	2.13.43	2.13.51	2.13.47	1.22					
54,9	4.13.40	4.13.55	4.13.47,5	0.6					
54,95	Mean of ten intervals.					719,55	86160,14	1,28	86161,42

Observations of Coincidences, Pendulum 4, at Portland Place; the room being heated with charcoal.

March 11th; *Bar.* 29, 70; *Clock making* 86400,25 *vibrations in a mean solar day.*

°	h m s	h m s	h m s	°					
75,2	12.37.30	12.37.37	12.37.33,5	1.2					
75	49.00	49.09	49.04,5	1.12	1.16			2,192	
74	1.00.34	1.00.43	1.00.38,5	1.04	1.08			1,893	
74,4	12.07	12.17	12.12	0.98	1.01			1,673	
75	23.40	23.51	23.45,5	0.92	0.95			1,484	
76	35.14	35.25	35.19,5	0.86	0.89			1,299	
76	46.49	47.00	46.54,5	0.8	0.83			1,129	
75,3	58.22	58.35	58.28,5	0.74	0.77			0,972	
75,5	2.09.58	2.10.10	2.10.04	0.7	0.72			0,848	
76,2	21.32	21.46	21.39	0.66	0.68			0,759	
76,5	33.06	33.23	33.14,5	0.62	0.64			0,668	
75,37	Mean of ten intervals.					694,1	86151,29	1,292	86152,582

March 13th, A. M.; Bar. 30, 20; Clock making 86400,35 vibrations in a m. solar day.

Temp.	Times of coincidence. Disap.	Reapp.	Mean.	Arc of vib.	Mean Arc.	Interval in sec'ds.	Observed vib. in 24 hours.	Corrections for Arc.	Vibration in 24 hours.
°	h m s	h m s	h m s	°					
80,5	11.34.08	11.34.15	11.34.11,5	1.24					
					1.2			2,36	
80	45.34	45.43	45.38,5	1.16					
					1.12			2,06	
79,7	57.02	57.09	57.05,5	1.08					
					1.04			1,774	
79,7	12.08.30	12.08.39	12.08.34,5	1.00					
					0.97			1,543	
79,8	19.59	20.09	20.04	0.94					
					0.91			1,358	
80	31.28	31.38	31.33	0.88					
					0.85			1,135	
79,8	42.58	43.07	43.02,5	0.82					
					0.79			1,023	
79,6	54.27	54.39	54.43	0.76					
					0.74			0,898	
80,3	1.05.58	1.06.11	1.06.04,5	0.72					
					0.7			0,804	
80,2	17.30	17.41	17.35,5	0.68					
					0.66			0,714	
79,8	29.58	29.13	29.05,5	0.64					
79,94	Mean of ten intervals.					689,4	86149,68	1,367	86151,047

March 13th, P. M.; Bar. 30, 18; Clock making 86400,35 vibrations in a m. solar day.

79,2	1.56.40	1.56.47	1.56.43,5	1.3					
					1.26			2,604	
80,5	2.08.06	2.08.15	2.08.10,5	1.22					
					1.18			2,183	
81,8	19.33	19.43	19.38	1.14					
					1.10			1,984	
81	30.59	31.09	31.04	1.06					
					1.02			1,707	
80,8	42.27	42.38	42.32,5	0.98					
					0.95			1,484	
80	53.56	54.07	54.01,5	0.92					
					0.89			1,299	
81,4	3.05.26	3.05.36	3.05.31	0.86					
					0.83			1,129	
80,2	16.56	17.06	17.00,5	0.80					
					0.77			0,972	
80	28.23	28.38	28.30,5	0.74					
					0.71			0,776	
81,7	39.52	40.08	40.00	0.68					
					0.66			0,714	
81	51.20	51.40	51.30	0.64					
80,7	Mean of ten intervals.					688,65	86149,42	1,485	86150,905

April 5th, P. M.; Bar. 29, 07; Clock making 86399,87 vibrations in a m. solar day.

53,3	1.21.00	1.21.06	1.21.03	1.28					
53,1	1.21.28	1.21.38	1.21.33	0.64					
53,2	Mean of ten Intervals.					723	86160,86	1,44	86162,3

April 6th, P. M.; Bar. 29, 25; Clock making 86399,87 vibrations in a m. solar day.

57	12.35.43	12.35.50	12.35.46,5	1.3					
57	2.35.25	2.35.36	2.35.30,5	0.64					
57	Mean of ten intervals.					718,4	86159,34	1,485	86160,825

The next table contains the preceding results, collected and exhibited in one view; the several reductions have been computed as already described in the similar table in the observations at New-York: the three last enumerated experiments, wherein the room was heated by charcoal, were designed to try the correctness of the allowance for expansion, by the comparison of results obtained under great differences of temperature; the heat was kept up to nearly the same amount for several hours before the pendulum was set in motion, but in spite of endeavour, was too fluctuating during the period of the coincidences, to entitle the results to be considered as decisive in a matter of so much delicacy and minuteness; the detail of these three experiments has been given at length, in order that the amount of this fluctuation may be seen, and the consequent diminution of value in the results appreciated: inasmuch, however, as they may still deserve estimation, they justify, by their agreement with the nine preceding observations at the lower temperature, the allowance of 0, 435 of a second in 24 hours for each degree of Fahrenheit, which has been adopted on the assumption that the expansion of plate brass may be taken at a mean at 0.0218 of an inch per foot, for 180°, or .0000101 parts of the length of the pendulum for a change of temperature of one degree: it is desirable to establish the ratio of expansion of the individual pendulums by experiment, and it is purposed to be accomplished when they shall have been brought back from the Arctic Circle, for which they are on the point of embarkation; the difference in the number of vibrations in 24 hours at the same spot in widely differing, but well ascertained temperatures, appears much preferable, in this determination, to the methods of instrumental measurement, and is peculiarly suitable to the purpose for which the rate of expansion is wanted; but it will be an operation of much delicacy, requiring that the possible errors from every other source shall be reduced with certainty within very narrow limits, in order that any difference between the assumed and the real expansion may be detected, and its effect, which can only be very minute, attributed with confidence to its true cause.

It is in this respect only that the account of the experiments now com-

municated can be considered as otherwise than complete; the uncertainty which is thus involved is however too inconsiderable to have justified a delay in their communication; it is more than probable that 0. 435 per diem will prove a nearer approximation to the truth than either 0. 43 or 0. 44; but the difference which the adoption of either of these numbers would produce in the acceleration between New-York and London, deduced from these experiments, made as they were in temperatures differing 19 degrees from each other, would be less than one tenth of a vibration in the 24 hours, and consequently less than $\frac{1}{15.000}$th of an inch in the length of the pendulum at New-York; when, however, the correct allowance shall have been ascertained by actual experiment, its amount shall be notified, and the influence on the final deduction of this paper computed, and duly communicated.

Vibrations of the detached Pendulums in Portland Place, London, Lat. 51° 31′ 08,4″ N.; Elevation 83,5 feet above the sea.

Pendulum 3d.

Date.	Barom.	Vibrations in 24 hours.	Temp	Corr. to mean Temperat. 53 degrees.	Vibrations in 24 hours Temperat. 53 degrees.	Corrections.		Vib. in a m. solar day, in a vacuum of the level of the sea.
						Buoyancy	Elevation	
1823.	Inches		°	s		s	s	Temp. 53°.
March 19, A. M.	29 . 75	86152 . 2	53 , 6	+0 , 26	86152 . 46			
„ P. M.	29 . 75	86152 . 2	53 , 6	+0 , 26	86152 . 46			
20, A. M.	29 . 60	86153 . 29	51 , 05	−0 , 84	86152 . 45			
„ P. M.	29 . 60	86153 . 49	51	−0 , 86	86152 . 63			
21.	29 . 25	86152 . 02	54 , 85	+0 , 79	86152 . 81			
22, A. M.	29 . 15	86152 . 16	54 , 5	+0 , 64	86152 . 8			
„ P. M.	29 . 15	86152 . 09	54 , 8	+0 , 77	86152 . 86			
24, P. M.	30 . 20	86151 . 77	54 , 75	+0 , 75	86152 . 52			
25, A. M.	30 . 20	86152 . 24	53 , 5	+0 , 22	86152 . 46			
	29 . 64		53 , 5		86152 . 6	6,066	0,344	86159 , 01

Pendulum 4th.

Date.	Barom.	Vibrations in 24 hours.	Temp.	Corr. to mean Temperat. 53 degrees.	Vibrations in 24 hours Temperat. 53 degrees.	Corrections		Var. in a m. solar day, in a vacuum of the level of the sea.
						Buoyancy	Elevation	
1823.	Inches		°	s		s	s	Temp. 53.°
March 4, A. M.	29 . 30	86162 . 527	52 , 9	−0 , 043	86162 . 484			
„ P. M.	29 . 35	86162 . 632	52 , 9	−0 , 043	86162 . 589			
5, A. M.	29 . 45	86162 . 91	51 , 8	−0 , 516	86162 . 394			
„ P. M.	29 . 50	86162 . 68	52 , 35	−0 , 28	86162 . 40			
6, A. M.	29 . 75	86162 . 81	52	−0 , 43	86162 . 38	6 , 027	0 , 345	86168 , 78
23, A. M.	29 . 65	86161 . 48	54 , 75	+0 , 75	86162 . 23			
P. M.	29 . 65	86161 . 42	54 , 95	+0 , 838	86162 . 258			
April 5, P. M.	29 . 07	86162 . 3	53 , 2	+0 , 086	86162 . 386			
6, P. M.	29 . 25	86160 . 825	57	+1 , 72	86162 . 545			
The room heated by a Charcoal fire.								
March 11, P. M.	29 . 70	85152 , 528	75 , 37	+9 , 619	86162 , 201			
13, A. M.	30 . 20	86151 , 047	79 , 94	+11,584	86162 , 631	5 , 832	0 , 345	86168 , 726
13, P. M.	30 . 18	86150 , 905	80 , 7	+11,91	86162 , 815			
	29 . 59		59 , 89		86162 , 444	5 , 971	0 , 345	86168 , 76

Results of the preceding operations.

It now remains to recapitulate the results of the operations that have been detailed, and to state the deduction therefrom:

It has been seen that the invariable pendulum No. 3 would make 86117. 164 vibrations, and No. 4: 86126, 732 vibrations in a mean solar day, at New-York, in a vacuum, and at the level of the sea, the temperature being 53 degrees of Fahrenheit; and that the same pendulums would make respectively 86159. 01, and 86, 168, 76 vibrations under the same circumstances and temperature in London; being an acceleration between New-York and London of 41. 937 vibrations in 24 hours; from which determination, the seperate results by each pendulum differ less than one tenth of a vibration; being within the limit assigned in page 12, to the difference which it was therein contemplated might be occasioned (but without prejudice to the mean result) in the apportionment of the rate of the clock at New-York to the division of the interval, for the whole period of which the rate corresponded, though it possibly might not with the same precision to the half intervals: taking, therefore, the mean of the two pendulums as a representation of the number of

vibrations which a single pendulum continued through the whole interval of the experiments at each station would have made, the force of gravity at London and at New-York, will appear to be in the inverse proportion of $\overline{86163,855}^2$ to $\overline{86121,948}^2$; whence, if the length of the seconds pendulum in London be 39, 1393 inches of Sir George Shuckburgh's Standard Scale, its length at New-York will be 39, 1012 inches of the same scale; this determination being subject to a correction, amounting possibly to a single unit in the last figure, when the expansion of the pendulums of comparison due to differences of temperature, shall have been correctly ascertained by further experiment.

It may not be uninteresting to annex to the preceding details, an account of the going of two other pendulums of comparison at New-York and at London, also invariable except by changes of temperature, but differing from the former in the mode adopted in experimenting with them, being applied successively to a clock which preserved their motion by its maintaining power, and registered their oscillations: the clock and pendulums were the same which I had employed in determining the acceleration between London and Melville Island, as recorded in the philosophical transactions for 1821; since which time, however, the clock had been cleaned and the knife edges of the pendulums ground afresh. The clock was set up at New-York in the Antiroom to the Library of the College, which is immediately beneath the apartment in which the detached pendulums were used; its going in the same interval from the 22d of December to the 4th of January, was ascertained by comparison with the chronometer No. 423, whose rate has been already shown: during this period no fire was lighted in the stove; but, as it would have been inconvenient to have darkened the apartment, the changes of temperature in the 24 hours were greater than in the room above, and though still not very considerable, would have required a far more frequent registry than it would have been

in my power to have made, in order to have brought their results in competition, in point of minute accuracy, with those of the detached pendulums, supposing even that the two methods were equally unobjectionable in theory: a mean between the extremes in the 24 hours registered, by the same Six's thermometer, has been taken as the mean temperature of the interval, in the present instances, as also, indeed, at all the equatorial stations; wherefore the registered may be supposed generally to exceed by a small amount, the true mean temperature in cases where there has been no interference of artificial heat.

The experiments by this method were designed rather to exemplify the dependence which may be inferred on results obtained by means of a pendulum attached to a clock, than to afford a corroboration of the results of the detached pendulums; they may, however, be regarded as a confirmation, to a certain extent, when they agree within an amount which may reasonably be ascribed to the insufficient registry of the temperature, as is the case in the present instance, and has been hitherto, at all the stations at which the two methods have been tried in comparison. In the subjoined tables it is shown that the pendulum numbered 1, being kept in motion by the clock, would make 86334, 698 vibrations, and No. 2, 86444, 878 vibrations in a mean solar day, in a vacuum at the level of the sea, and at the temperature of 53 degrees; and that the same pendulums in the same clock, in London, would make respectively 86376, 244, and 86486, 26 vibrations under like circumstances and temperature; the reductions in these tables having been computed as already described, except that as the pendulums are of cast instead of plate brass, their expansion has been taken at 0, 0220 of an inch per foot for 180 degrees of Fahrenheit, making a corresponding correction of 0,44 for each degree of temperature to be applied to the number of vibrations in 24 hours.

The acceleration deducible from the preceding results is as follows; from the first half interval 41, 546 seconds per diem by pendulum No. 1; and from the second half interval 41, 382 seconds by pendulum No 2; a mean of the whole interval and of the two pendulums being 41, 464, which is less than the result of the detached pendulums by 0,474 per diem.

It has been already stated that the mean temperature of the experiments, with the attached pendulums at New-York, having been estimated from a mean between the extremes in 24 hours, when the progress of natural temperature was uninfluenced by artificial heat, might be considered to exceed the true mean temperature by a small amount; the corresponding experiments in London were made in Mr. Browne's Library, where a fire is always kept during the day, and where, consequently, the temperature of the apartment approaches the maximum of the registry at an earlier hour, and continues in proportion higher to a later hour than where the sun is the only source of heat; in such circumstances, therefore, the registered mean may rather be *below* than, as in the former case, *above*, the true mean; and being in opposite directions, the acceleration will be affected by the sum of the differences between the true and registered temperatures: now it will be perceived that a difference of half a degree, or more precisely 0. 53 or $\frac{53}{100}$ of a degree of Fahrenheit at each station, in the directions which were certainly anticipated as probable in both instances, before the observations were examined, would make the results of the two methods of experiment identical.

To have caused the results of the attached Pendulums to have been comparable, in point of minute accuracy, with those of the detached pendulums, would have required not merely a more frequent registry of temperature, but that the experiments with the former should have been continued through a much longer period than it was expedient to employ; there are many persons who are of opinion that a detached pendulum needs no confirmation, and others that it can receive none, from a pendulum applied to a clock; but those whose opinions are not so decided, will probably consider the present approximation as satisfactory evidence of the agreement which more time, and an equal attention to both methods, might have been expected to have produced.

An account of the going of the Pendulum Clock at Columbia College, New-York; Elevation above the Sea 52 feet.

With the Pendulum marked No. 1; Barom. mean height 30. 2.

1822.	Chron. 423. Losing 2s,615.	Pendulum Clock.	Clock's daily loss. on 423.	Clock's daily loss. on time.	Mean Arc	Temperature. Extremes.	Temperature. Means.	Corrections. Arc.	Corrections. To Tem 55°.	Corrections. Buoyancy.	Corrections. Elevation.	Vibrations in a m. solar day in a vacuum at the level of the sea.
Dec.												Temp. 53°
22		7 . 02 . 15,6	68,6		1.7	42 / 37. 2	39,6					
23		7 . 01 . 07	65,8		1.68	36. 2 / 31	33,6					
24		7 . 00 . 01,2	65,7		1.68	31. 2 / 36. 2	33,7					
25	7 . 10 . 00	6 . 58 . 55,5	65		1.69	31. 4 / 34. 7	33,05					
26		6 . 57 . 50,5	64,3		1.68	31 / 34. 4	32,7					
27		6 . 56 . 46,2										
	Means.		65,88	68,495	1.686		34,53	4.662	8.127	6.443	0.215	86334, 698

The Clock was going four or five days before the account was taken up; the correction for temperature is 0s.44, per diem for each degree of Fahrenheit.

With the Pendulum marked No. 2; Barom. 30. 36.

			Clock's gain.									
28		7 . 42 . 50,5	46		1.68	31 . 6 / 32 . 4	32					
29		7 . 43 . 36,5	44,9		1.68	31 . 2 / 34 . 7	32.95					
30		7 . 44 . 21,4	45,6		1.68	32 / 33 . 5	32.75					
31		7 . 45 . 07	45,7		1.68	35 . 3 / 29 . 3	32.3					
1823 Jan. 1	7 . 10 . 00	7 . 45 . 52,7	45,3		1.7	33 . 4 / 29 . 8	31.6					
2		7 . 46 . 38	43,2		1.7	36 / 31	33.5					
3		7 . 47 . 21,2	43,6		1.68	37 . 3 / 34 . 8	36.05					
4		7 . 48 . 04,8										
	Means.		44.9	42,285	1.686		33.02	4.662	8.791	6.507	0.215	86444.878

An account of the going of the Pendulum Clock in Portland Place, London; Elevation above the Sea 83,5 feet.

With the Pendulum marked No. 1; Barom. mean height 29. 33.

1822.	Cumming losing 0s.14 per diem.	Pendulum Clock.	Clock's daily loss. on Cumming.	Clock's daily loss. on time.	Mean Arc.	Temperature. Extremes.	Temperature. Mean.	Corrections. Arc.	Corrections. To Tem 55°.	Corrections. Buoyancy.	Corrections. Elevation.	Vibrations in a m. solar day, in a vacuum at the level of the sea.
Feb.												Temp. 53°
21		3 . 42 . 12,4	35,2		1.75	52 . 8 / 54 . 6	53.7					
22		3 . 41 . 37,2	35,1		1.74	53 . 2 / 54 . 8	54					
23		3 . 41 . 02,1	35.3		1.75	53 / 55 . 6	54.3					
24	3 . 30 . 00	3 . 40 . 26,8	35.9		1.73	53 . 8 / 55 . 4	54.6					
25		3 . 39 . 50,9	35.7		1.74	52 . 4 / 55	53.7					
26		3 . 39 . 15,2	35.2		1.75	52 . 4 / 55	53.7					
27		3 . 38 . 40	35.1		1.74	51 . 6 / 54 . 6	53.1					
28		3 . 38 . 04,9			1.75							
	Means.		35,36	35,5	1.744		53.9	4,988	0,396	6,015	0,345	86376.244

With the Pendulum marked No. 2; Barom. mean height.

Mar.	losing 0,24		Clock's daily gain.									
1		2 . 07 . 42,6	75,3		1.72	52 . 6 / 54 . 2	53.4					
2		2 . 08 . 57,9	74,3		1.72	53 . 8 / 55 . 2	54.5					
3		2 . 10 . 12,2	74		1.72	53 . 4 / 54 . 9	54.15					
4		2 . 11 . 26,2	74,2		1.73	53 . 3 / 55 . 9	54.6					
5		2 . 12 . 40,4	74,3		1.73	53 . 8 / 55 . 2	54.5					
6	2 . 00 . 00	2 . 13 . 54,7	75		1.73	53 . 2 / 54 . 4	53.8					
7		2 . 15 . 09,7	75,5		1.73	52 . 8 / 54 . 2	53.5					
8		2 . 16 . 25,2	75,3		1.73	52 . 7 / 53 . 3	53					
9		2 . 17 . 40,5	75,3		1.73	52 . 8 / 54 . 2	53.5					
10		2 . 18 . 55,8			1.73							
	Means.		74,8	74,56	1,727		53.9	4,891	0,396	6,085	0,346	86486,26

Having adverted, in the early part of this paper, to the means which the experiments, herein recorded, afford of comparing the measurement which has been made in London with the result of such operations as may hereafter be instituted, to determine, de novo, the absolute length of the seconds pendulum at New-York, I wish, in conclusion, briefly to notice the more prominent advantages which might be expected to accrue from such a comparison, to both the nations, as well as to science generally; *first*, in the event of perfect accordance in the results.

A natural standard would be thereby determined in the United States, at once and finally, being founded on experiments which had already received the testimony of repetition: in Great Britain, such confirmation of the measurement which she has already adopted as the basis of her scale of linear measure, could not be regarded otherwise than as highly satisfactory; whilst, in regard to science generally, in this its connexion with purposes of national importance, a very valuable practical demonstration would be afforded of the identity with which the length of the pendulum can be ascertained and measured on the national scale, and of its consequent applicability as a natural standard of reference.

Second; in any other event than that of perfect accordance, the advantages which might be gained by the comparison might even be expected to be greater than in the former case, by reason of the further investigation to which it would give rise, and which would terminate, doubtless, eventually in the same important conclusion as in the former supposition, but with increased assurance.

The value of a method of determining a length in nature, which is to fix in perpetuity a national standard, is essentially dependant on the certainty with which its repetition by others as well as by the original experimenter, and at all distances of time, shall conduct to an identical result; wherefore that process is obviously the best in which the identity is governed by the method, and is least dependant on the amount of skill or of practical experience possessed by the individual who may conduct the experiments; if a high degree of skilfulness were required, the measure would not be easily accessible, which is one of the first properties of a good natural standard; and

if even with such skilfulness, identity is not ensured, then is the measurement not invariable, and it would have no effective value as a standard, since the invariability of the measurement is no less important for such purpose than that of the length itself. The preference which appears to be generally given to the method of determining the length of the seconds pendulum invented by Captain Kater, over that of Messieurs Borda and Biot, may be principally attributed to the result of the former being less dependant on individual skill than that of the latter; with regard to the first part of the process, especially, it can scarcely be doubted that the pendulum with convertible axes of suspension affords a certain means of reproducing at pleasure a determinate length; it is in the second part of the process, namely, in the measurement of this length on the national scale, that a proof of the identity or repetition would be a most satisfactory testimony; perhaps a more decisive one could not be furnished than by a repetition in the United States, where the artists would be guided in the construction of the necessary instruments, and the experimentor in the mode of employing them, solely by the report of the original proceedings; the perspicuity and sufficient fullness of which would thereby be submitted to the tests of experience.

It has been presumed in these concluding observations, in conformity with the recommendation contained in the report on weights and measures made by the Secretary of State to the senate in 1821, that the United States are, or shortly will be, in possession of a standard linear measure, which has been compared with the French or British scales with the utmost attainable instrumental accuracy; and if with either, then effectively with both, since the value of each, in parts of the other, has been correctly ascertained.

It may, finally, be observed, that by a repetition of the original experiments at New-York, this comparison would be assured; the standard measures of both nations would receive reciprocal confirmation; and would descend to future ages as having been referred to a standard in nature, which is not only supposed, but has actually been proved, to be reproducible.

No more published

if even with such skilfulness, identity is not ensured, then is the measurement not invariable, and it would have no effective value as a standard, since the invariability of the measurement is no less important for such purpose than that of the length itself. The preference which appears to be generally given to the method of determining the length of the seconds pendulum invented by Captain Kater, over that of Messieurs Borda and Biot, may be principally attributed to the result of the former being less dependant on individual skill than that of the latter; with regard to the first part of the process, especially, it can scarcely be doubted that the pendulum with convertible axes of suspension affords a certain means of reproducing at pleasure a determinate length; it is in the second part of the process, namely, in the measurement of this length on the national scale, that a proof of the identity or repetition would be a most satisfactory testimony; perhaps a more decisive one could not be furnished than by a repetition in the United States, where the artists would be guided in the construction of the necessary instruments, and the experimentor in the mode of employing them, solely by the report of the original proceedings; the perspicuity and sufficient fullness of which would thereby be submitted to the tests of experience.

It has been presumed in these concluding observations, in conformity with the recommendation contained in the report on weights and measures made by the Secretary of State to the senate in 1821, that the United States are, or shortly will be, in possession of a standard linear measure, which has been compared with the French or British scales with the utmost attainable instrumental accuracy; and if with either, then effectively with both, since the value of each, in parts of the other, has been correctly ascertained.

It may, finally, be observed, that by a repetition of the original experiments at New-York, this comparison would be assured; the standard measures of both nations would receive reciprocal confirmation; and would descend to future ages as having been referred to a standard in nature, which is not only supposed, but has actually been proved, to be reproducible.

ARTICLE III.

A Memoir on the ANTIQUITIES *of the Western parts of the State of* NEW-YORK, *addressed to the Honourable Samuel L. Mitchill, a Vice-President of the Literary and Philosophical Society of New-York, Professor of Natural History in the University of the State, &c. by* DEWITT CLINTON, LL. D.

Read before the Society November 13th, 1817.

SIR,

BACON describes antiquities, "history defaced, or some remnants of history which have casually escaped the shipwreck of time. Tanquam tabula naufragii, when industrious persons by exact and scrupulous diligence and observation, out of monuments, names, words, proverbs, traditions, private records and evidences, fragments of stories, passages of books that concern not story, and the like, do save and recover somewhat from the deluge of time."

The antiquities of our country have always appeared to me important, and to deserve more attention than they have heretofore received. We have indeed no written authorities or documents to recur to, except the ancient French and Dutch writers; and it is well known that their attention was almost wholly absorbed in the pursuit of wealth or in the propagation of religion, and that their sentiments were shaped by reigning prejudices, regulated by preconceived theories, controlled by the policy of their sovereigns, and obscured by the darkness which then covered the world.

To rely entirely on the traditions of the aborigines for authentic or extensive information, is to lean on a broken reed. Those who have interrogated them must know that they were generally as ignorant as the inquirer—that the ideas they communicated were either invented at the moment, or were so connected with palpable fable as to be almost entirely unworthy of credit. Having no written auxiliaries to memory, the facts with which they were acquainted became in process of time obliterated from the mind, or distorted by new impressions and new traditions. If in the

course of thirty years the Buccaneers of St. Domingo lost almost every trace of Christianity, what confidence can we repose in the oral history delivered to us by savages, without the use of letters, and continually engrossed in war or in the chase.

The field of inquiry is then limited in its range, but happily it is not entirely closed against us. The monuments which remain afford considerable room for investigation. The languages, the persons, and the customs of the Red Men may be made use of to illustrate their origin and history—and even the geology of the country may in some cases be successfully applied to shed light on the subject of inquiry.

Having had some opportunities for personal observation, and not a few for inquiry, I am induced to believe that the western parts of the United States were, prior to their discovery and occupation by Europeans, inhabited by numerous nations in a settled state, and much further advanced in civilization than the present tribes of Indians. Perhaps it is not too much to say that they did not fall far short of the Mexicans and Peruvians when first visited by the Spaniards. In my illustrations of this subject, I shall principally confine myself to this state, occasionally glancing beyond it; and avoiding, as far as possible, topics which have been heretofore discussed.

The town of Pompey, in the county of Onondaga, is the highest ground of that country; and divides the waters which flow into the Bay of Chesapeake and the Gulf of St. Lawrence. The most elevated parts of the town exhibit the remains of ancient settlements; and in various other parts of it the vestiges of a numerous population appear.

About two miles south from Manlius Square, and in the town of Pompey, I examined the remains of a large town, which were obviously indicated by large spots of black mould in regular intervals of a few paces distant, in which I observed bones of animals, ashes, carbonized beans or grains of Indian corn, denoting the residence of human beings. This town must have extended at least half a mile from east to west, and three quarters of a mile from north to south. This extent I could determine with considerable accuracy from my own view; but I was assured by a gentleman of veracity

that its length from east to west was one mile. A town covering upwards of five hundred acres must have contained a population greatly transcending all our ideas of credibility. A mile to the east of the settlement there is a burying ground containing three or four acres, and close to the west end there is another. This town was on elevated ground, about twelve miles distant from the salt springs of Onondaga, and was well calculated for defence. On the east side there is a perpendicular descent of one hundred feet into a deep ravine, through which a fine stream flows, and on the north side a similar one. There are three old forts distant about eight miles from each other, and forming a triangle which encloses the town; one a mile south of the present village of Jamesville, and the others north-east and south-east in Pompey; and they were in all probability erected to cover the town, and to protect the inhabitants against the attacks of an enemy. All these forts are of a circular or elliptical form. There are bones scattered all over the ground. An ash tree growing on it was cut down, and the concentric circles showed it to be ninety-three years old. On a heap of mouldered ashes, composing the site of a large house, I saw a white pine tree eight and a half feet in circumference, and at least one hundred and thirty years old. On the line of the north side the town was probably stormed. There are graves on each side close to the precipice; sometimes five or six persons were thrown promiscuously into the same grave. If the invaders had been repulsed, the inhabitants would have interred the killed in the usual places; but from the circumstance of there being graves near the ravine and in the village, I am induced to believe that the town was taken.

On the south side of this ravine, a gun-barrel, several bullets, a piece of lead, and a skull perforated by a ball, were discovered. Indeed gun-barrels, axes, swords, and hoes, are found all over these grounds; and I procured the following articles, which I now transmit to the society to be deposited in their collection—two mutilated gun-barrels, two axes, a hoe, a bell without a clapper, a piece of a large bell, a finger-ring, a sword-blade, pieces of bayonets, gun-locks, and earthen ware, a pipe, door-latch, beads, and several other small things. These demonstrate European intercourse, and

from the attempts which were evidently made to render the gun-barrels useless by filing them, there can be little doubt but that the Europeans who had settled here, were defeated, and driven from the country by the Indians.

Near the remains of this town I observed a large forest which was in former times cleared and under cultivation; and I drew this inference from the following circumstances.—There were no hillocks or small mounds, which are always the result of up-rooted trees—no up-rooted decaying trees or stumps—no underwood, and the trees were generally fifty or sixty years old. Many, very many years must elapse before a cultivated country is covered with wood. The seeds must be slowly conveyed by winds and birds. The town of Pompey abounds with forests of a similar character. Some are four miles long and two wide. And it contains a great number of ancient places of interment. I have heard them estimated at eighty. If the present white population of that country were entirely swept away, perhaps in the revolution of ages similar appearances would exist.

It appears to me that there are two distinct æras in our Antiquities—one applicable to the remains of old fortifications and settlements which existed anterior to European intercourse, and the other referring to European establishments and operations.—And as the whites as well as the Indians would frequently resort to the former for protection, habitation or hunting, they must necessarily contain many articles of European manufacture, and thereby much confusion has resulted by blending together distinct æras greatly remote in point of time.

The French had undoubtedly large establishments in the territory of the Six Nations. A quarto volume in Latin, written by Francis Creuxius, a Jesuit, was published at Paris in 1664, and is entitled "Historiæ Canadensis seu novæ Franciæ, Libri decem, ad annum usque Christi M.D.CLVI." It states that a French colony was established in the Onondaga territory about the year 1655, and it thus describes that highly fertile and uncommonly interesting country.—"Ergo biduo post ingenti agmine deductus est ad locum Gallorum sedi atque domicilio destinatum, leucas quatuor dissitum a pago, ubi primum pedem fixerat. Vix quidquam a natura videre sit abso-

lutius: ac si ars, ut in Gallia, ceteraque Europa, accederet, haud temere certaret cum Baiis. Pratum ingens cingit undique silva cædua ad ripam Lacus Gaunentaæ, quo nationes quatuor principes Iroquiæ totius regionis tanquam ad centrum navigiolis confluere perfacile queant, et unde vicissim facillimus aditus sit ad eorum singulas, per amnes lacusque circumfluentes—Ferinæ copia certat cum copia piscium, atque ut ne desit quidquam, turtures eo undique sub veris initium convolant, tanto numero, ut reti capiantur, piscium quidem certe vis tanta, ut piscatores esse ferantur, qui intra unius noctis spatium anguillas ad mille singuli hamo capiant—Pratum intersecant fontes duo, centum prope passus alter ab altero dissiti: alterius aqua salsa, salis optimi copiam subministrat—alterius lympha dulcis ad potionem est; et quod mirere uterque ex uno eodemque colle scaturit." It appears from Charlevoix's History of New France that missionaries were sent to Onondaga in 1654—that they built a chapel and made a settlement—that a French colony was established there under the auspices of Le Sieur Dupuys, in 1656, and retired in 1658—and that the missionaries finally abandoned the country in 1668.—When La Salle started from Canada, and went down the Mississippi in 1679, he discovered a large plain between the lake of the Hurons and that of the Illinois on which was a fine settlement belonging to the Jesuits.

The traditions of the Indians agree in some measure with the French relations. They represent that their forefathers had several bloody battles with the French, and finally compelled them to abandon the country—that the French, after being driven from their last fortress, capitulated and agreed to depart on being furnished with provisions—that the Indians filled their bags with ashes covered with corn, and that the greater part of the French in consequence fell victims to famine at a place called by them "Anse de famine"—and by us "Hungry Bay," on Lake Ontario. There is a hill in Pompey which the Indians will not visit, and which they call Bloody Hill. It is surprising that no old Indian weapons, such as stone-knives, axes, and arrow-heads, are found in this country. It appears that they were superseded by French substitutes of iron.

The following statement, received from a respectable source, may throw considerable light on this subject.

The public have made many inquiries respecting certain remains, appearing to be those of houses, &c. &c. at *Pompey-hill;* but as far as I am able to learn, have hitherto been unsuccessful.

At the early settlement of the country by the English, there was to be seen the apparent remains of a small village, with evident vestiges of a black-smith's shop, &c. &c. the origin of which no one could tell. Yet, strange as it may seem, I believe that the following statement, collected partially from the sachems of the Six Nations, and partially from the manuscript journals of one of the French Jesuits, will fully and satisfactorily account for this long hidden mystery.

From the Jesuit's journal it appears that in the year 1666,* at the request of *Karakontie*, an Onondaga chieftain, a French colony was directed to repair to his village for the purpose of teaching the Indians arts and sciences, and endeavour if practicable to civilize and christianize them.

We learn from the sachems that at this time the Indians had a fort a short distance above the village of Jamesville, on the banks of a small stream near; a little above which, it seems, the chieftain, *Karakontie*, would have his new friends *set down*. Accordingly they repaired thither and commenced their labours, which being greatly aided by the savages, a few months only were necessary to the building a small village.

This little colony remained, for three years, in a very peaceable and flourishing situation, during which time much addition was made to the establishment, and among others, a small chapel, in which the Jesuit used to collect the barbarians and perform the rites and ceremonies of his church.

But the dire circumstance which was to bury this colony in oblivion, and put their history in secret, was yet to come. About this time (1669) a party of Spaniards, consisting of twenty-three persons, arrived at the village,

---

*This colony has been confounded with the one under Monsieur Dupuys, established in 1566, and abandoned in 1568.—But the history of his establishment is on record.

having for guides some of the Iroquois, who had been taken captive by the southern tribes. It appears evident that this party came up the Mississippi, as it has been ascertained that they passed Pittsburgh, and on to Olean Point, where leaving their canoes, they travelled by land. They had been informed by some of the southern tribes, that there was a lake at the north of them, whose bottom was covered with a substance shining and white,* and which they took, from the Indians' description, to be silver; and it is supposed that the idea of enriching themselves on this treasure induced them to undertake this long and desperate journey—for silver was the first thing inquired for on their arrival, and on being told that none was ever seen, in or about the Onondaga lake, they became almost frantic, and seemed bent upon a quarrel with the French, and charged them with having bribed the Indians, and even those who had been their guides, that they would not tell where the mines might be found. Nor dare they, finding the French influence to prevail, venture out on a search, fearing lest the Indians might destroy them. A compromise was however made, and both parties agreed that an equal number of each should be sent on an exploring expedition, which was accordingly done. But the effect of this upon the minds of the Indians was fatal. Upon seeing these strangers prowling the woods with various kinds of instruments, they immediately suspected some plan to be in operation to deprive them of their country.

Nor was this jealousy by any means hushed by the Europeans. The Spaniards averred to the Indians that the only object of the French was to tyrannize over them—and the French, on the other hand, that the Spaniards were plotting a scheme to rob them of their lands.

The Indians by this time becoming equally jealous of both, determined, in private council, to rid themselves of so troublesome neighbours. For aid in this, they sent private invitations to the Oneidas and Cayugas who only wanted a watch-word to be found immediately on the ground. The matter

---

*It is said that at this time the salt in the Onondaga lake had this appearance, and even crystallizes on the grass and weeds.

was soon digested, and the time and manner of attack agreed upon. A little before day-break on *All saints* day, 1669—the little colony, together with the Spaniards, were aroused from their slumbers by the roaring of fire arms, and the dismal war-whoop of the savages. Every house was immediately fired, or broken open; and such as attempted to escape from the flames, only met a more untimely death in the *tomahawk.* Merciless multitudes overpowered the little band, and the Europeans were soon either lost in death or writhing in their blood—and such was the furious prejudice of the savages that not one escaped or was left alive to *relate the sad disaster.* Thus perished the little colony whose labours have excited so much wonder and curiosity.

The French in Canada, on making inquiries respecting the fate of their friends, were informed by the Indians that they had gone towards the south with a company of people who came from thence, and at the same time showing a *Spanish coat of arms* and other national trinkets, confirmed the Canadian French in the opinion that their unfortunate countrymen had indeed gone thither, and in all probability perished in the immense forests.

This opinion was also measurably confirmed by a Frenchman, who had long lived with the Senecas, and who visited the Onondagas at the time the Spaniards were at the village, but left before the disaster, and could only say that he had seen them there.

The old fortifications were erected previous to European intercourse. The indians are ignorant by whom they were made: and in the wars which took place in this country, it is probable that they were occupied as strong holds by all the belligerents. And it is likely that the ruins of European works of a different construction may be found in the same way that Roman and British fortifications are to be seen in the vicinity of each other in Great Britain. It is remarkable that our ancient forts resemble the old British and Danish. Penant, in his tour in Scotland, says "On the hill near a certain spot is a circular British entrenchment, and I was told of others of a square form at a few miles distance, I suppose Roman." And in his tour through Wales he describes "a strong British post on the summit of

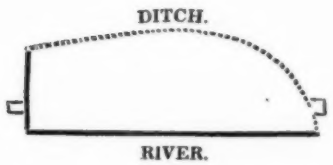
a hill in Wales of a circular form, with a great fosse and dike, and a small artificial mount within the precinct." How exactly does this correspond with our old forts. The Danes, as well as the nations which erected our fortifications, were in all probability of Scythian origin. According to Pliny, the name of Scythian was common to all the nations living in the north of Asia, and Europe.

In the town of Camillus in the same county of Onondaga about four miles from the Seneca river, thirty miles from lake Ontario, and eighteen from Salina, there are two ancient forts on the land of Judge Monro, who has been settled there about nineteen years. One is on a very high hill, and its area covers about three acres. It had one eastern gate, and in the west there was another communicating with a spring about ten rods from the fort. Its shape elliptical. The ditch was deep, and the eastern wall ten feet high. In the centre was a large lime stone, of an irregular shape, which could be raised by two men—the bottom was flat, and three feet long. It contained, in the opinion of Judge Monro, unknown characters plainly figured on the stone to the extent of eighteen inches in length, and three inches in breadth. When I visited this place the stone was not to be seen, and my inquiries to find it were unsuccessful. I saw the stump of a black oak on the wall one hundred years old, and about nineteen years ago there were indiciæ of two preceding growths. The second fort is about half a mile distant, on lower ground, constructed like the other, and is about half as large. Near the large fort there are the marks of an old road, now covered by trees. I also saw in several places in this town, on high ground, considerable ridges stretching from the top to the bottom of the hills, and the gullies between of no great width. This phenomenon occurs in very ancient settlements, where the soil is loamy and the hill steep, and it is occasioned by crevices produced and gradually enlarged by torrents. In a forest state this result cannot occur: and this evinces that these grounds were cleared in ancient times. When settled by us they exhibited the same appearance as now, except being covered by woods: and as stumps are now to be seen in the gullies, the ridges and intervening small ravines could

not have been made by the last clearing. The first settlers observed shells of testaceous fishes accumulated in great masses in different places, (perhaps the shell-fish of the Lakes,) and numerous fragments of pottery. Judge Monro found, in digging the cellar of his house, several pieces of brick. In various places there were large spots of deep black mould, demonstrating the former existence of buildings and erections of different kinds: and Judge Monro seeing the appearance of a well, viz. a hole ten feet deep, and the earth considerably caved in, he dug three and a half feet deep, and came to a parcel of stones, below which he found a peck of human bones, which pulverized on exposure to the air. This is strong evidence of the destruction of an ancient settlement. The disposal of the dead was unquestionably made by an invading enemy.

I also observed on Boughton's Hill in Ontario county, where a bloody battle is said to have been fought, black spots of mould at regular intervals, and yellow clay between. The most easterly fortifications yet discovered in this region are about eighteen miles east of Manlius Square, with the exception of the one in Oxford, Chenango county, hereafter mentioned.—To the north they have been discovered as far as Sandy creek, about fourteen miles from Sacket's Harbour. Near that place there is one that covers fifty acres, and that contains numerous fragments of pottery. To the west there are great numbers. There is a large one in the town of Onondaga—one in Scipio—two near Auburn—three near Canandaigua, and several between the Seneca and Cayuga lakes, there being three within a few miles of each other.

The fort before referred to as being in Oxford, is on the east bank of the Chenango river, in the centre of the present village, which is on both sides of the river. There is a piece of land containing between two and three acres, which is about thirty feet higher than the adjoining flat land around it.—This rise of land lies along the river bank about fifty rods, and at the southwesterly end this fort was situated. It contained about three roods of ground, and on the river the line was nearly straight, and the bank almost perpendicular. The figure like this.



At the places north and south, marked for gates, there were two spaces of about ten feet each, where the ground has not been broken, which were undoubtedly the entrances or gate-ways by which the people of the fort went out and in, and particularly for water. The curve, except the gate-way, was a ditch regularly dug, and although the ground on which the fort is situated was, at the first white settlement, as heavily timbered as any other part of the forest, yet the lines of the work could be distinctly traced among the trees, and the distance from the bottom of the ditch to the top of the embankment generally about four feet. The antiquity of this fortification is more particularly evident from the following facts—There was one large pine tree, or rather dead trunk, fifty or sixty feet high, which being cut, one hundred and ninety-five circles could be easily distinguished, and many more could not be counted, as the sap wood of the tree was principally gone. Probably this tree was three or four hundred years old, certainly more than two hundred. It might have stood one hundred years after it had completed its growth, and even longer. It is also uncertain how long a time elapsed from the excavation of the ditch to the commencement of the growth of this tree. That it was not there when the earth was thrown up is certain, for it stood on the top of the bank, and its roots had shaped themselves to the ditch, running quite under the bottom of it, then rising on the other side near the surface of the earth, and then pursuing a horizontal direction. Probably this work was picketed in, but no remains of any wooden work have been discovered. The situation was very eligible, being healthy, commanding a beautiful prospect up and down the river, and there being no highlands within such a distance that the garrison could be annoyed. No vestiges of any implements or utensils have been found except some

pieces of coarse pottery resembling stone-ware, and roughly ornamented. The Indians have a tradition that the family of the Antones, which is supposed to belong to the Tuscarora nation, are the seventh generation from the inhabitants of this fort, but of its origin they know nothing. There is also a place at Norwich, in the same county, on a high bank of the river, called the castle, where the Indians lived at the period of our settling the country, and some vestiges of a fortification appear there, but it is in all probability of a much more modern date than the one at Oxford.

In the town of Ridgway, in Genesee county, there have been discovered several ancient fortifications and burying places. About six miles from the ridge road, and south of the Great Slope or Mountain Ridge, an old burying ground has been discovered within two or three months, in which are deposited bones of an unusual length and size. Over this ground lay the trunk of a chestnut tree, apparently four feet through at the stump. The top and limbs of this tree had entirely mouldered away by age. The bones lay across each other in a promiscuous manner; from which circumstance, and the appearance of a pit in the neighbourhood, it is supposed that they were deposited there by their conquerors. And from the fort being situated in a swamp, it is believed it was the last resort of the vanquished, and probably the swamp was under water at the time.

There are extensive clearings in the Indian reservation at Buffalo, of which the Senecas can give no account. Their principal settlements were at a great distance to the east until the sale of the greater part of their country since the conclusion of the revolutionary war.

On the south side of Lake Erie, as I am informed, there is a series of old fortifications running from the Cataraugus creek to the Pennsylvania line, a distance of fifty miles. Some are two, three, and four miles apart, and some within half a mile. Some contain five acres—the walls or breastworks of earth; and they are generally on ground where there are appearances of creeks having once emptied into the lakes, or where there was once a bay—so that it is inferred that these works were once on the margin of Lake Erie, which has now retreated from two to five miles northerly—

Still further south there is said to be another chain of forts running parallel with the former, and about the same distance from them as those are from the lake. The country here exhibits two different tables or sections of bottom, intervale or alluvial land—the one nearest the lake being the lower, and if I may so denominate it, the secondary table land. The primary or more elevated table land is bounded on the south by hills or vallies where nature exhibits her usual aspects. The primary alluvial land was formed from the first retreat or recession of the lake, and then it is supposed the most southern line of fortifications was erected. In process of time the lake receded further to the north, leaving another section of table land on which the other tier of works was made. The soil on the two flats is very different, the inferior being adapted for grass, and the superior for grain—and the timber varies in a correspondent manner. On the south side of Lake Ontario there are also two alluvial formations—the most recent is north of the Ridge Road. No forts have been discovered on it—whether there be any on the primary table land I have not learned—South of the mountain ridge many have been observed.

In the geology of our country, it is important to remark that the two alluvial formations before mentioned are, generally speaking, characteristic of all the lands bordering on the western waters; while on the eastern waters there is oftener but one alluvial tract. This may be ascribed to the distance of the St. Lawrence and the Mississippi from the ocean—their having prostrated at different periods impediments or barriers, and in consequence of thus lowering the beds in which they flowed, having produced a partial exhaustion of the remote waters. These distinct formations may be considered as great chronological land-marks. The non-existence of forts on the secondary or primary alluvial formations of Lake Ontario is a strong circumstance from which the remote antiquity of those on the highlands to the south may be deduced; because if they had been erected after the first or last retreat of the lake, they would undoubtedly have been made on them as most convenient and best adapted for all military, civil, and domestic purposes.

The Iroquois formerly lived, according to their traditions, on the north side of the lakes. When they migrated to their present country they extirpated the people who occupied it. And after the European settlement of America, the confederates destroyed the Eries or Cat Indians, who lived on the south side of Lake Erie. Whether the nation which possessed our western country before the Iroquois had erected those fortifications to protect them against their invaders—or whether they were made by anterior inhabitants, are mysteries which cannot be penetrated by human sagacity—Nor can we pretend to decide whether the Eries or their predecessors raised the works of defence in their territory. But we are persuaded that enough has been said to indicate the existence of a vast population, settled in towns, defended by forts, cultivating agriculture, and more advanced in civilization than the nations which have inhabited the same countries since the European discovery.

DEWITT CLINTON.

ALBANY, *7th October*, 1817.